"A PROSPECTIVE STUDY OF SURGICAL MANAGEMENT OF LUMBAR DISC PROLAPSE BY FENESTRATION TECHNIQUE''

By

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LIST OF ABBREVIATIONS USED

A	-	Absent
CT	-	Computed Tomography
CSF	-	Cerebrospinal Fluid
DTR	-	Deep tendon reflexes
ECG	-	Electrocardiogram
EHL	-	Extensor hallucis longus
EMG	-	Electro myography
FHL	-	Flexor hallucis longus
Hb	-	Hemoglobin
%	-	Percentage
MRI	-	Magnetic resonance imaging
S	-	Sacral
SLRT	-	Straight leg raising test
TENS	-	Transelectrical Nerve Stimulation

ABSTRACT

TITLE OF DISSERTATION: A PROSPECTIVE STUDY OF SURGICAL MANAGEMENT OF LUMBAR DISC PROLAPSE BY FENESTRATION TECHNIQUE.

INTRODUCTION:

Low back pain due to lumbar disc prolapse is the major cause of morbidity throughout the world affecting mainly the young adults. Lifetime incidence of low back pain is 50-70 % with incidence of sciatica more than 40 %. Intervertebral disc occurs predominately in L4-L5 & L5-S1 level.

Detailed history, clinical examination supplemented by relevant radiological investigations can differentiate herniated lumbar disc prolapse from other causes of low back pain and sciatica. The outcome of surgery depends on many factors, such as careful selection of patients.

AIMS AND OBJECTIVES:

To study and evaluate the functional outcome of surgical management of lumbar disc prolapse by fenestration technique**.**

METHODS :

The material for the present study was collected from patients who attend and are admitted in Department of Orthopaedics in BLDEU'S Shri B.M.Patil's Medical College, Hospital and Research Centre, Vijayapur with diagnosis of single level or two level disc prolapse. 26 cases of either sex were studied. The patients were informed about study in all respects and informed written consent was obtained. Period of study was from October 2013- August 2015.

Follow up was done immediate post-operative period, 1 month, 3 months and 6 months.

RESULTS :

14 patients had disc prolapse at L4-L5 and 9 patients had disc prolapse at L5-S1 and 1 at L3-L4 level and 2 patients had two level disc prolapse at L4-L5 and L5-S1.The last group underwent fenestration at two levels simultaneously

The results were evaluated using the criteria similar to those of Mac Nab's and JOA score. The pre-operative mean $\pm$ SD(SE) JOA score was 8.346$\pm$0.85(0.169) which improved to 11.807$\pm$0.694(0.136) after 1 month and 13.19$\pm$0.895(0.175) after 6 months. According to Mac Nab's criteria we had excellent outcome in 10(38.46%) patients and good in 12(46.15%) patients fair in 2 (7.69%) patients and poor in 2(7.69%) patients.

CONCLUSION

The results of this study show that enough space is available in interlaminar area to perform fenestration and disc excision without removing much of lamina. The results are comparable to microdiscectomy in standard references.

In conclusion, interlaminar lumbar discectomy by fenestration method without extensive laminectomy is effective and reliable surgical technique for treating properly selected patients with herniated lumbar disc.

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INTRODUCTION

From adolescence to adulthood, 80 to 85% of people suffer from low back pain in the modern world. It results in tremendous loss of time and work productivity costing billions of dollars[1].Incidence of sciatica is more than forty percent in low backache patients. However clinically significant sciatica due to prolapsed lumber intervertebral disc is only four to six percent[2]. Lumbar disc disease forms the second most common cause for medically authorized absence from work[3]. The pain is due to the irritation of the dural covering of the nerve root by the protruded part of intervertebral disc[4]. Pressure on the nerve root itself causes parasthesia and numbness in the corresponding dermatome as well as weakness and diminished reflexes in the corresponding mytomes[5].

In orthopedic practice patients having lesions of lumbosacral region causing low backache with sciatica are not uncommon since the beginning of recorded history. The first disc prolapse operation falsely accredited to Mixter and Barr had been conducted by Oppenhein and Krause in Berlin but interpreted it as an enchondroma of spinal disc[6,7]. Mixter and Barr's classical paper "Rupture of intervertebral disc with involvement of spinal canal" opened an era of systematic diagnosis and operative treatment of lumber disc prolapse. Their operative approach was an extensive laminectomy[8].

Shortly afterwards hemilaminectomy became the favourite procedure in cases with unilateral symptoms. Love described extradural removal of herniated disc and devised interlaminar fenestration for treatment of lumber disc prolapse[9]. Refinement of fenestration technique was described by Williams who coined the term "Conservative surgical approach to the virgin herniated disc" which required the use

of operating microscope to facilitate better visualization of dural sac, nerve roots and other interspinal structures including disc[10]. The advantages of fenestration and interlaminar approach has been demonstrated[11,12,3]. Mishra et al compared laminectomy and fenestration for disc excision and concluded the superiority of later approach in respect to early postoperative mobilization, early return to work and low incidence of postoperative backache as it is less extensive[14]. It is very safe, effective and reliable surgical technique for treating properly selected patients with herniated disc. This approach is free from spinal instability and membrane formation resulting from laminectomy[15].

The recent techniques like percutaneous lumbar disc decompression (PLDD), percutaneous endoscopic lumbar discectomy (PELD) and Young endoscopic spine system (YESS) need lots of expertise, experience and expensive equipments which are not available at every center[16,17]. Hence disc excision through fenestration is the procedure which can be performed by majority of orthopaedic surgeons even in small peripheral centers.

AIMS AND OBJECTIVES

To study and evaluate the functional outcome of surgical management of lumbar disc prolapse by fenestration technique.

REVIEW OF LITERATURE

Forst[18] in 1881 first described the passive straight leg raising test, after his attention had been drawn to it by Lasegue.

Goldthwait J.E[19] in 1911 first made the observation that an intervertebral disc lesion was responsible for compression of the cauda equina and sciatica.

Mixter and Bar[20] in 1934 published a classic paper titled "Rupture of the intervertebral disc with involvement of the spinal canal".

Love[21] in 1938 described extradural removal of a herniated disc and proposed limited surgical exposure

O'Connell[22] in 1951 in a clinical review based on the five hundred cases of protrusions of the lumbar intervertebral discs treated by excision concluded that: excision of a lumbar intervertebral disc is required in only a small proportion of patients with this lesion. A careful clinical and radiological examination of cases of lumbago and pain in the lower limb provides good evidence not only of the presence of a lumbar intervertebral disc protrusion but also of its anatomical level, size and relationships.

In 1939, Semmen presented a new procedure to remove the ruptured IV disc that included subtotal laminectomy and retraction of dural sac to expose the disc and to remove the ruptured disc with the patient under local anaesthesia.[23]

In 1970, Williams, Wilken, Harburgh Maroon, Albar, Casper, Yasergil, Saunder and many others recommended microsurgical removal of disc, which was more exact and less stressful.[24,25]

Many authors have tried to develop early alternative methods to replace conservative methods. In pursuing this goal, Smith (1964) tried to dissolve nucleus

pulposus by intradiscal injection of Chymopapain. Hijikatha, Kaumbin, Gellman developed the percutaneous mechanical discectomy.[24]

In 1982, Splenger in his extensive study concluded that limited disc excision with selective fenestration produced very good results provided the herniated disc is single level and midline. He also concluded that limited disc excision lessens the likelihood of anterior penetration of the annulus with potential injury to vessels and for viscera. The rationale for this procedure is justifiable, especially in light of good results now being reported with lumbar discectomy using the operating microscope.[24,26]

Michel Newman in 1995 did outpatient conventional fenestration and disc excision in 75 cases and concluded that outpatient surgery is a practical alternative for selected patients requiring disc surgery.[27]

In 1989, Neil Kahanovitz and Joh Maculloch did a clinical comparative study of limited surgical discectomy and microdiscectomy in a group of 64 patients and concluded that microdiscectomy was no way clinically superior to limited discectomy through limited laminectomy. Same conclusion was drawn in earlier studies by Fager CA in 1987.

A study of the neurological signs in lumbar disc herniation by Bo Jonsson and Bjorn Stromqvist showed that neurological recovery was seen in half the cases at 2 years post operatively. Neurologic recovery correlated to a good surgical outcome, and a short history of disc herniation prior to the operation correlated to postoperative neurologic improvement. The straight led raising test correlated to preoperative neurologic deficit, but not to postoperative recovery. Motor power disturbances of the extensor hallucis longus muscle recovered in more patients than reflex disturbances. Sensory disturbances had the lowest recovery rate. The study demonstrates correlation

between routine postoperative neurologic findings and the patient's self assessed outcome of surgery.

A long term prospective study of 100 patients undergoing lumbosacral discectomy was carried out, by Jeffrey Lewis in an attempt to delineate the natural history of these patients and to assess the relative significance of preoperative factors as determinants of long term outcome. An 8.3 years long term follow up result was obtained. At a minimum of 5 years postoperatively, 62% of patients had complete relief of back pain and 62% had complete relief of leg pain; 96% were pleased that they had submitted to surgery and 93% were able to return to work. Nine percent reported that their back pain at 5 to 10 years was as severe as or worse than preoperatively. The reoperation rate was 18%. Preoperative factors found to be significantly associated with outcome at 1 year postoperatively were not significantly associated with outcome at 5 to 10 years postoperatively. The results of lumbosacral discectomy appear favourable as evaluated in this study. Preoperative factors useful as predictors of short-term outcome are much less reliable when considering the long-term results. These factors were number of previous hospitalization, duration of leg pain, straight leg-raise examination, presence of osteophytes, disc bulge, and duration of surgery.[28,29]

Astrand in a prospective study of 161 patients with lumbar discectomy found that pain relief was not associated with neurological signs but was associated with lumbar mobility and root tension signs. Patients without neurological symptoms before the surgery did not report more sciatica after 2 years than did those with positive mobility before surgery predicted better chances for postoperative pain relief. Patients with ruptured annulus fibrosus at surgery had less sciatica and back pain after surgery than those patients with an intact annulus fibrosus.[24]

It was Kambin and Gellman who reported on the percutaneous approach for lumbar discectomy. Later, Ebeling reported on the 485 patients who underwent microsurgical discectomy and has found that microsurgery gave consistently high results (88%-98%) as compared to standard technique which had more variable results (40%-98%) and concluded that only surgeons highly experienced in the standard technique were capable of giving as consistent result as microsurgical techniques.

Roy Silvers compared patients treated with standard discectomy with those who underwent microsurgical discectomy and found 98% success rate in microsurgical discectomy as compared to 95% success rate in standard laminectomy and discectomy.

He also found that the postoperative hospital stay and time taken to return to the normal work was found to be less in patients undergoing microdisectomy. Casper in his comparative study of microsurgical discectomy and conventional standard lumbar disc surgery found that in addition to less blood loss, faster ambulation, faster discharge and earlier return to work, the results of microsurgical group was found to be more favourable.[24]

Tullberg studies the difference in the results between microsurgical discectomy and standard procedure in a set of 60 patients with single level lumbar disc herniation. He found that the microscope had no effect on the results of the surgery and so the decision to use the microscope was to be left to the operating surgeon.[30]

In a study by Mochida on percutaneous nucleotomy it was found that a 73% of success rate was noted with this procedure as compared to 88% success rate with open surgery.

Nagi, in 1985 reported 93.5% good to excellent result with discectomy by fenestration method and found it to be an extremely satisfactory method. His criteria for surgery were

- Accentuation of symptoms with cough/sneezing
- Position of comfort – hip and knee flexion
- Positive SLR.
- Restriction of spinal movements
- Spinal tenderness.

A study to know the efficacy of disc excision by fenestration method for the relief of lumbar radicular pain in patients with prolapsed intervertebral disc was carried out in Department of neurosurgery of Hayatabad Medical Complex, Peshawar between October 2008 to September 2010 by Riaz ur rehman, Waqar alam and Azmatullah kattak.

One hundred and nine patients were studied. Sixty were male and fifty nine were female patients. Age rang was from 19 to 52 years with mean age 34.31 years. The most common level of involvement was L 4 -L 5 (n=67) followed by L 5 -S 1 (n=42) . Sixty five patients had left sided symptoms while forty four had right sided. Majority of patients presented in Dennis pain scale 4 i.e. 66.97% (n=73). Twenty patients (18.36%) were in P3 and 16 patients (14.67%) were in Dennis pain scale 5. Complete pain relief (P1) , three weeks after disc excision ,was achieved in 90 (82.57%) patients .Fourteen patients(12.85%) were in P2 and five(4.58%) patients in P3 according to Dennis pain scale. No patients in this study deteriorated after surgery.

They concluded that surgical treatment provides quick pain relief in selected patients with prolapsed intervertebral disc. Fenestration with disc excision is quite a reasonable method to surgically treat the indicated cases of prolapsed disc.

Fenestration offers complete visualization of nerve root and complete removal of the offending disc. This procedure does not need greater know-how, expertise in instrumentation and techniques.[31]

In 2012 a study of Long-Term Clinical Outcomes in Patients Undergoing Lumbar Discectomy by Fenestration of 60 patients by J Shi, Y Wang, F Zhou, H Zhang and H Yang found that the long-term outcome of lumbar discectomy by fenestration was satisfactory in the majority of patients. Heavy manual work, smoking and the duration of aggressive preoperative symptoms were negative predictors of a good clinical outcome.[32]

A study of Comparison of outcomes between conventional lumbar fenestration discectomy and minimally invasive lumbar discectomy: an observational study with a minimum 2-year follow-up conducted on 66 patients by Shiju A Majeed**,** C S Vikraman**,** Vivek Mathew and Anish T S at Department of Orthopedics, Government Medical College, Trivandrum, India, in 2013 found that that both MLD and fenestration give comparable results at short-term follow-up. There is statistically significant improvement in MLD with regard to improvement in JOA, VAS and RM scores at 2 years. However, the difference is not large and may not be clinically significant.[33]

ANATOMY OF THE LUMBAR SPINE

1. DEVELOPMENT OF VERTEBRAE:

The vertebrae develop from the sclerotome parts of the mesodermal somites. The sclerotomes surround the notochord and neural tube in a sheath of mesoderm. A series of hyaline cartilaginous rings appears in the mesodermal sheath. Each ring is formed by fusion of adjacent halves (caudal and cranial) of the original somites. Thus the vertebrae lie not in segments of the body wall, but in the intersegmental planes.

Each ring ossifies in three centres to form the centrum and the two halves of the neural arch of a vertebra. The centre for the centrum is initially double, but the two areas rapidly fuse.Failure of one half results in a hemivertebra.A series of hemivertebrae is one cause of congenital scoliosis (lateral curvature of the spine). By the eighth week of fetal life ossification has commenced in the centrum and the two halves of the neural arch. At birth a vertebra consists of three ossifying parts, centrum and two half arches, united by cartilage. The half arches unite in the first year after birth, first in the lumbar, then thoracic and finally cervical regions. The centra unite with the arches first in the cervical region, about the third year, but in the lumbar region this union is not complete until the sixth year.

The vertical cylindrical surface of the body is covered with compact bone, but the cancellous bone on the flat upper and lower surfaces remains covered with a layer of hyaline cartilage. The epiphyses for the body appear as bony rings, upper and lower, soon after puberty. They are ridged and grooved reciprocally with the margins of the surfaces of the body. Fusion of the epiphyseal ring and body occurs in the early twenties. Soon after puberty secondary centres appear also at the tip of the spinous process (double in the bifid spines of the cervical vertebrae) and at the tips of the transverse processes of all the vertebrae, and in the mamillary processes of T12 and

the lumbar vertebrae. These fuse in the early twenties. The costal elements of cervical and lumbar vertebrae do not have a separate bony centre, but ossify by direct extension from the neural arch. An occasional centre in the costal element of C7 and L1 vertebrae may lead to the formation of a cervical or lumbar rib. On the other hand the weight- bearing costal elements of the sacrum have primary ossification centers. In general the development of the five segments of the sacrum resembles that of typical vertebrae. After puberty these segments coalesce from below upwards.

2. GENERAL FEATURES OF VERTEBRAE

The general features of vertebrae are best exemplified by a thoracic vertebra. It consists of a ventral body and a dorsal vertebral or neural arch. They enclose between them the vertebral foramen (vertebral canal is the collective name given to the whole series of foramina when the vertebrae are strung together as a column). From the neural arch three processes diverge, in the posterior midline, the spinous process or spine, and on either side the transverse processes. That part of the neural arch between spinous process and transverse process is the lamina, that between transverse process and body is called the pedicle. The vertical height of the pedicle is less than that of the body, to allow room for passage of the spinal nerve through the intervertebral foramen between the pedicles of adjacent vertebrae. At the junction of lamina and pedicle (i.e., at the root of the transverse process) are articular processes, superior and inferior, which have hyaline cartilage facets for the synovial joints between the neural arches. The direction of the facets determines the nature of the movement possible between adjacent vertebrae.

3. LUMBAR VERTEBRAE

The bodies of lumbar vertebrae increase in breadth from above down, and this is reflected posteriorly by a progressive widening between the articular processes.

Thus in L1 and 2 the four processes as seen from behind make a rectangle set vertically. In L3 they may also make a vertical rectangle, or they may be like those of L4 and make a square; in L5 they make a horizontal rectangle. The body shares with the smaller thoracic vertebrae the characteristics of being concave from above down, of having pedicles attached to its upper half, and of being perforated by a pair of basivertebral veins posteriorly. It differs from the heart-shaped thoracic vertebra in being kidney-shaped, and the posterior surface is flatter, less concave from side to side, so the vertebral canal is somewhat triangular in cross-section.

The transverse processes are variable in length, but the fourth is usually the longest. The transverse process of the fifth, however, is quite characteristic. Short, massive, triangular, it base is attached to both the pedicle and the lateral side of the body itself.

The pedicles are stout and form the upper and lower margins of the intervertebral foramina. The laminae do not show such a downward slope as in the thoracic vertebrae. The quadrangular spinous process is roughly horizontal. The upper border is straight but the lower border is concave.

The articular processes are characteristic. The upper pair rise up and carry articular facets that face medially. The articular surfaces are concave from front to back. The lower pair of articular processes project down, face laterally and are convex from front to back.

The transverse processes are fused ribs (costal elements). The true transverse element consists of two small elevations with a groove between them occupied by the medial branch of the posterior ramus of the overlying lumbar nerve. The mamillary process is a convexity projecting back from the margin of the superior articular process. The smaller accessory tubercle lies below this, at the root of the transverse

process.

The inferior articular processes of the fifth lumbar vertebra face well forwards, and are received into backward-facing facets on the sacrum, and this locking prevents L5 vertebra from sliding forwards down the slope of S1 vertebra. Furthermore, the adjacent bodies are strongly united by the intervertebral disc.

Fig. No.1: Lumbar vertebrae assembled: left lateral view.

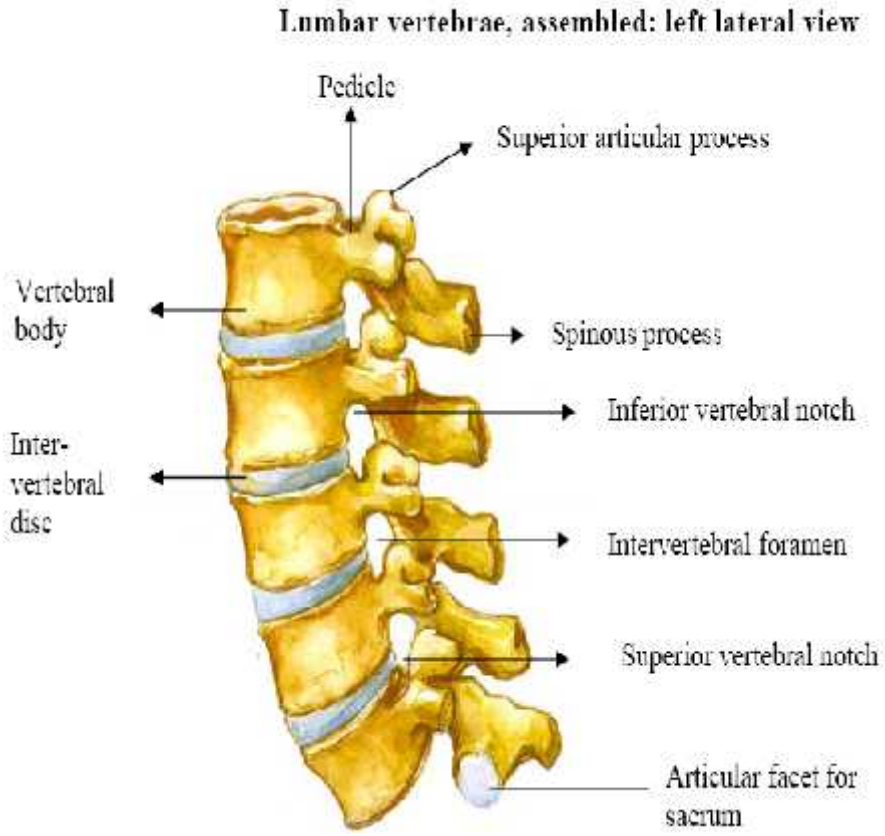


Fig. No. 2: Lumbar vertebrae Superior view and Intervertebral disc.

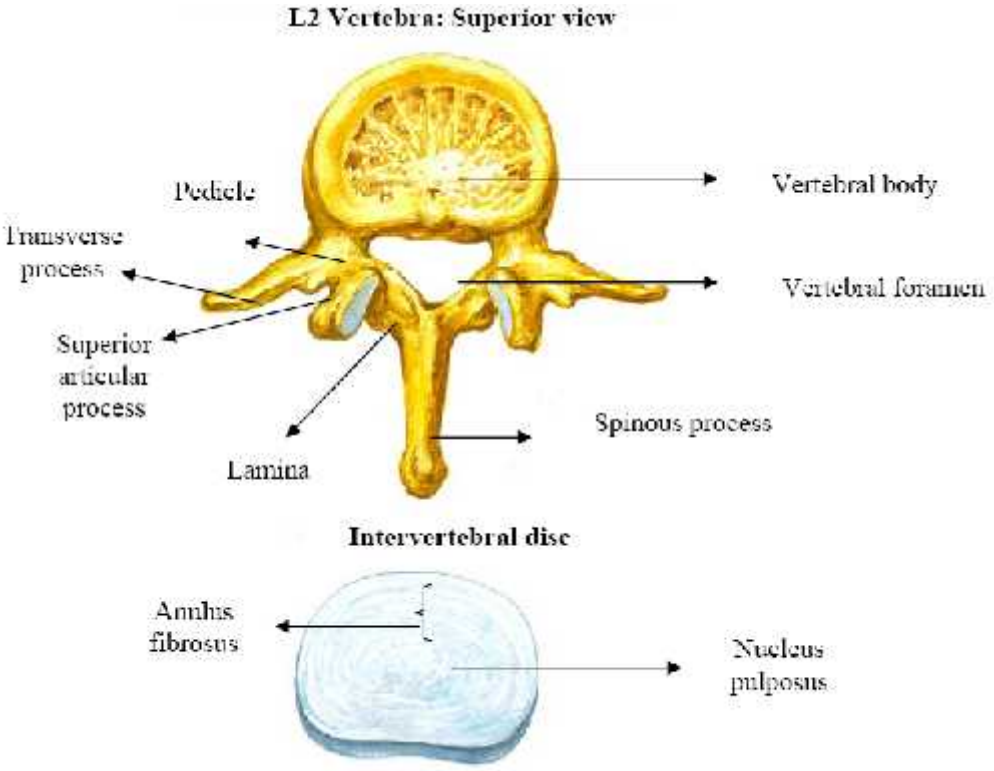
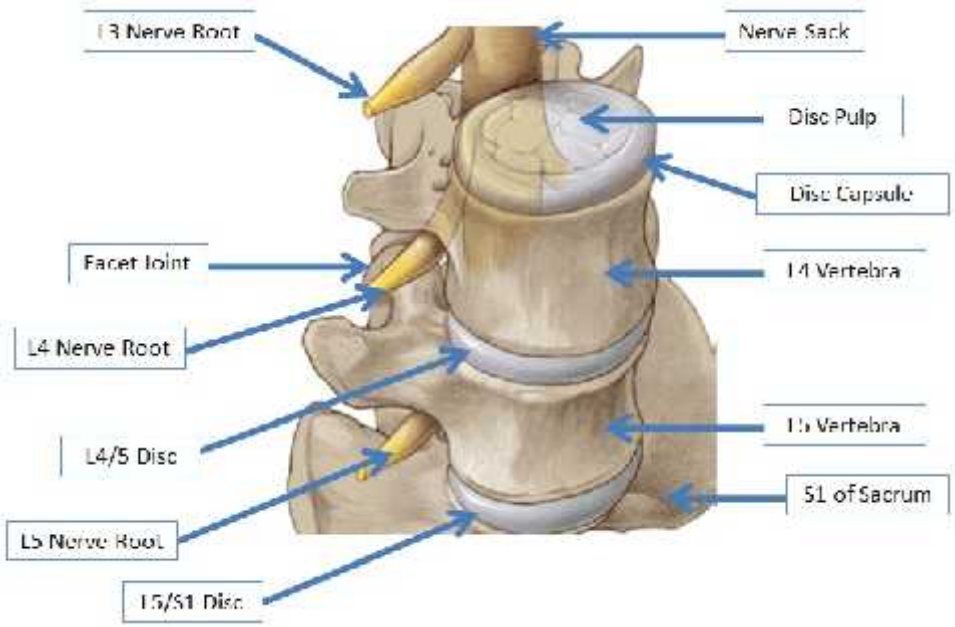


Fig. No. 3: Lumbar spine L4-L5



4. VERTEBRAL JOINTS

I. Joints between the bodies

The bodies of adjacent vertebrae are held together by the strong intervertebral disc, and by the anterior and posterior longitudinal ligaments. **A. An Intervertebral disc**

Is a secondary cartilaginous joint, or symphysis. The upper and lower surfaces of each vertebral body are covered completely by a thin plate of hyaline cartilage. These plates are united by a peripheral ring, the annulus fibrosus, which has a narrow outer collagenous zone and a wider inner fibrocartilaginous zone. It consists of concentric laminae, the fibres of which lie at 25-45° with the horizontal plane. Alternate layers of he annulus contain fibres lying at right angles to each other. By this means the annulus is able to withstand strain in any direction. Inside the annulus pulposus, derived from the embryonic notochord. (The notochord extended originally as far cranially as the sella turcica, but it disappears except in the nucleus pulposus of each intervertebral disc and in the apical ligament of the atlas.) The nucleus pulposus in the embryo lies at the center of the disc. Subsequent growth of the vertebral bodies and discs occurs in a ventral and lateral direction (the spinal cord prevents a corresponding growth dorsally). Thus in the adult and especially in the lumbar region the nucleus pulposus lies nearest to the back of the disc and if it herniates through the annulus it will be most likely to do so posteriorly and press on the roots of a spinal nerve near the intervertebral foramen, or on the spinal cord itself.

The nucleus pulposus accounts for 15% of the whole disc. It contains about 90% water at birth, and this diminishes to about 70% in old age. The water content keeps the nucleus under constant pressure since its mucoprotein (proteoglycan)

component has the property of imbibing and retaining water. Imbibition of water by the nucleus accounts for the overnight increase in height of a young adult by 1cm. When upright during the day, water is squeezed out. In old age there is little height change between night and morning. Imbibition pressure becomes less and the nucleus more fibrous. In astronauts, who have been relieved of gravity, there may be a height increase of several centimeters.

The relationship of nerve roots to intervertebral discs is of great importance, and is best understood by considering the lowest disc the fifth lumbar or lumbosacral disc – which is the one most frequently herniated or prolapsed (slipped disc), with its nucleus pulposus being extruded posterolaterally. At the level of this fifth lumbar disc, the fifth lumbar nerve roots within their dural sheath have already emerged from the intervertebral foramen, hugging the pedicle of L5 vertebra and so not lying low enough to come in contact with the fifth lumbar disc. The roots that lie behind the posterolateral part of this disc are those of the first sacral nerve, and these are the ones liable to be irritated by a prolapse. Thus the general rule throughout the vertebral column is that when a disc herniates (usually posterolaterally rather than in the midline) it may irritate the nerve roots numbered one below the disc SI nerve L5 disc; L5 nerve by L4 disc ; and C8 nerve by C6 disc (there are 8 cervical nerve roots and 7 cervical vertebrae). These are the commonest clinical examples.

B. Anterior Longitudinal Ligament

The anterior longitudinal ligament is a strong band of fibers that extends along the ventral surface of the spine from the skull to the sacrum. It is narrowest and cordlike in the upper cervical region, where it is attached to the atlas and axis and their intervening capsular membranes, but it expands in width as it descends the

column to the extent, in the lower lumbar region, of covering most of the antero-lateral surfaces of the vertebral bodies and discs before it blends into the presacral fibers. The anterior longitudinal ligament is not uniform in its composition or manner of attachment. Its deepest fibers, which span only one intervertebral articulation, are covered by an intermediate layer that unites two or three vertebrae and a superficial stratum that may connect four or five articular units. Where the ligament is adherent to the anterior surface of the vertebra, it also forms its periosteum, but it is most firmly attached to the articular lip at the end of each body. It is most readily elevated at the point of its passage over the midsection of the discs, where it is loosely attached to the connective tissue band that encircles the annulus.

C. Posterior Longitudinal Ligament

The posterior longitudinal ligament differs considerably from its anterior counterpart with respect to the clinical significance of its relations to the intervertebral disc. Like the anterior ligament, it extends from the skull to the sacrum, but being within the vertebral canal its central fiber bundles must diminish in breadth as the size of the spinal column increases. The segmental denticulate configuration of the posterior longitudinal ligament is one of its most characteristic features. Between the pedicles, particularly in the lower thoracic and lumbar regions, it forms a thick band of connective tissue that is not adherent to the posterior surface of the vertebral body. Instead, it is bowstrung across the concavity of the dorsum of the body and permits the large vascular elements to enter and leave the medullary sinus located beneath its fibers.

In approximating the dorsum of the disc, the posterior longitudinal ligament displays two strata of fibers. The superficial, longer strands form a distinct strong strap whose filaments bridge several vertebral elements. A second, deeper stratum

spans but two vertebral articulations and forms lateral curving extensions of fibers that pass along the dorsum of the disc and out through the intervertebral foramen. It is these deeper intervertebral expansions of the ligament that have the most significant relationship with the disc.

These fibers are most firmly fixed at the margins of their lateral expansion. This produces a central rhomboidal area of loose attachment or in some cases an actual fascial cleft of equivalent dimensions on the dorsum of the disc. At dissection this characteristic may be readily demonstrated by inserting a blunt probe beneath the intervertebral part of the longitudinal ligament and exploring the area to define the margins of the space where the fibers are strongly inserted. This situation is particularly pertinent to problems involving dorsal or dorsolateral prolapse of the nucleus pulposus. With a dorsocentral protrusion of a semifluid mass, the strong midline strap of posterior longitudinal fibers tends to restrain the herniation. However, if an easily dissectible cleft offers a space for lateral expansion, the mass then extends to either side, dissecting the loose attachment with interruption of numerous nerve fibers. The thinnest part of the lateral expansion of the posterior longitudinal ligament occurs at the convergence of its lines of attachment, and here it is most likely to permit a more dorsal protrusion from internal pressures.

Trabeculations of connective tissue bind the dura to the dorsal surface of the posterior longitudinal ligament, this attachment being the firmest along the lateral edges of the long superficial strap of fibers. Numerous venous cross connections of the epidural sinuses pass between the dura and the ligament, accounting for the fact that venous elements are the most ubiquitous structures among the components related to the vertebral articulations.

II. Joints between the Arches

The pedicles of adjacent vertebrae are not attached to one another, so leaving a space – the intervertebral foramen – for the emergence of the spinal nerve. All other parts of the neural arch and its processes are joined to their adjacent companions. The articular processes by synovial joints, and the remainder by ligaments, of which the most important are the ligamenta flava and the supraspinous ligament.

A. **Facet Joints or Zygapophyseal Joints** are the joints between the articular facets of the superior articular processes of one vertebra and the articular facets of the inferior articular processes of the vertebra. They are synovial with a simple capsule which blends medially with a ligamentum flavum. The articular surfaces allow gliding of one on the other. The direction of the surfaces determines the direction of the possible movements between adjacent vertebrae. The joints have a nerve supply from the nerve of their own segmental level and from the nerve of the segment above. This may be important when considering nerve root pain which can be referred from facet joints. Although most of the weight transmission by the vertebral column takes place via the vertebral bodies and intervening discs, a small amount does occur through these joints.

B. **Ligamenta Flava:** These are paired and are yellowish from their high content of elastic fibres. They join the contiguous borders of adjacent laminae. They are attached above to the front of the upper lamina and below to the back of the lower lamina. Thus adjacent laminae and ligamenta flava overlap each other slightly like the tiles of a roof. The ligamenta extend from the facet joints to the midline where they partially fuse.Small veins connecting the internal and external vertebral venous plexuses may pass between a pair of ligamenta. They are stretched by flexion of the spine.In leaning forward their increasing elongation

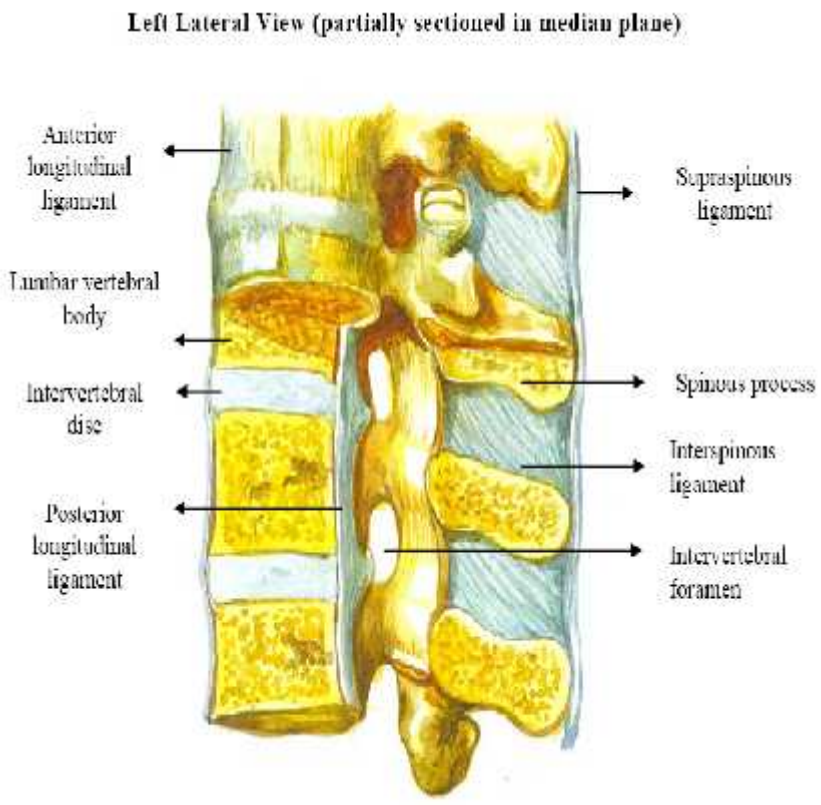
becomes an increasing antigravity support.

C. **Supraspinous Ligaments:** These join the tips of adjacent spinous processes. They are strong bands of white fibrous tissue and are lax in the extended spine. They are drawn taut by full flexion, and then support the spine.No action currents can be obtained from the erector spinae muscles when the spine is fully flexed, as in touching the toes. They are indistinct below the L4 spine where the lumbar fascia is thick. In the neck they are replaced by the ligamentum nuchae.

D. **Interspinous ligaments:** These are relatively weak sheets of fibrous tissue uniting spinous processes along their adjacent borders. They are well developed only in the lumbar region. They fuse with the supraspinous ligaments.

E. **Intertransverse ligaments:** These are similar weak sheets of fibrous tissue joining the transverse processes along their adjacent borders.

Fig. No. 4: Ligaments of lumbar vertebra



5. BLOOD SUPPLY OF THE VERTEBRAE

a. Arterial

From a segmental artery or its regional equivalent, each vertebra receives several sets of nutritional vessels, which consist of anterior central, posterior central, prelaminar, and postlaminar branches. The first and last of these are derived from vessels external to the vertebral column, whereas the posterior central and prelaminar branches are derived from spinal branches that enter the intervertebral foramina and supply the neural, meningeal, and epidural tissues as well. In the midspinal region the internal arteries (i.e., the posterior central and prelaminar branches) provide the greater part of the blood supply to the body and vertebral arch, but reciprocal arrangements may occur, particularly in the cervical region.

This general pattern of the vasculature is best demonstrated in the area between the second thoracic and fifth lumbar vertebrae, where the segments are associated with paired arteries that arise directly from the aorta. Typically, each segmental artery leaves the posterior surface of the aorta and follows a dorsolateral course around the middle of the vertebral body. Near the transverse processes it divides into a lateral (intercostal or lumbar) and a dorsal branch. The dorsal branch runs lateral to the intervertebral foramen and the articular processes as it continues backward between the transverse processes to eventually reach the spinal muscles. Since the segmental artery is closely applied to the anterolateral surface of the body, its first spinal derivatives are two or more anterior central branches that directly penetrate the cortical bone of the body and that may be traced radiologically into the spongiosa. The same region of the segmental artery also supplies longitudinal arteries to the anterior longitudinal ligament.

After the segmental artery divided into its dorsal and lateral branches, the

dorsal component passes lateral to the intervertebral foramen, where it gives off the spinal branch that provides the major vascularity to the bone and contents of the vertebral canal. This branch may enter the foramen as a single vessel, or it may arise from the dorsal segmental branch as a number of independent rami. In either case, it ultimately divides into a triad of posterior central, prelaminar, and intermediate neural branches. The posterior central branch passes over the dorsolateral surface of eth intervertebral disc and divides into a caudal and a cranial branch, which supply the two adjacent vertebral bodies. Coursing in the same plane as the posterior longitudinal ligament, these branches vascularize the ligament and the related dura before entering the large concavity in the central dorsal entering the large concavity in the central dorsal surface of the vertebral body. It is apparent, then, that the dorsum of each vertebral body is supplied by four arteries derived from two intervertebral levels. As these vessels tend to converge toward the dorsal central concavity, where they are cross-connected with their bilateral counterparts, their connections with other vertebral levels give the appearance of a series of rhomboid anastomotic loops that illustrate the extent of collateral supply to a single vertebra.

The prelaminar branch of the spinal artery follows the inner surface of the vertebral arch, giving fine penetrating nutrient branches to the laminae and ligamenta flava while also supplying the regional epidural and dorsal tissue.

The neural branches that enter the intervertebral foramen with the above-described vessels supply the pia-aracnoid complex and the spinal cord itself. In the fetus and the adult the neural or radicular branches are not segmentally uniform in their size or occurrence. Although all spinal nerves receive fine twigs to their ganglia and roots, the major contributions to the cord are found at irregular intervals. Several larger radicular arteries may be discerned in the cervical and upper thoracic regions,

but the largest, the arteria radicularis magna, is an asymmetric contribution from one of the upper lumbar segmental arteries. It travels obliquely upward with a ventral spinal root to join the anterior spinal artery in the region of the conus medullaris. Radicular contributions to the dorsal spinal plexus may usually be distinguished by their more tortuous course.

After the dorsal branch of the segmental artery has provided the vessels to the intervertebral foramen, it passes between the transverse processes, where it gives off a fine spray of articular branches to the joint capsule of the artcular processes. Immediately distal to this point, it divides into dorsal and medial branches. The larger, dorsal branch ramifies in the greater muscle mass of the erector spinae, while the medial branch follows the external contours of the lamina and the spinous process. This postlaminar artery supplies the musculature immediately overlying the lamina and also sends fine nutrient branches into the bone. The largest of these branches penetrates the lamina through a nutrient foramen located just dorosmedial to the articular capsule.

b. Venous:

The richly supplied red marrow of the vertebral body drains through its posterior surface by a pair of large basivertebral veins into the internal vertebral venous plexus, which lies inside the vertebral canal, outside the dura. It drains into the external vertebral venous plexus. This intramuscular plexus, which also receives blood from the neural arch, drains into the regional segmental veins (vertebral, posterior intercostals, lumbar and lateral sacral veins), which in turn drain into brachiocephalic veins, superior vena cava, inferior vena cava and internal iliac veins. Venous communication is thus established in the pelvis with veins draining the pelvic viscera, in the abdomen with the renal veins, in the thorax with the azygos venous

system (and thereby with the venous drainage of the breast and bronchus), and in the neck with the inferior thyroid veins.

6. LUMBAR MUSCULATURE

A. Intrinsic Muscles

Erector Spinae: This large and superficial muscle lies just deep to the lumbodorsal fascia and arises from an aponeurosis on the sacrum, iliac crest, and thoracolumbar spinous processes. The muscle mass is poorly differentiated but divides into three sections in the upper lumbar area: (1) the iliocostalis, which is most lateral and inserts into the angles of the rib; (2) the intermediate column, the longissimus, which inserts onto the tips of the spinous processes of thoracic and cervical vertebrae; and (3) the spinalis, which is most medial and inserts onto the spinous processes of the cervical and thoracic vertebrae.

Multifidi. This series of small muscles, best developed in the lumbar spine, originates on the mamillary processes of the superior facets and runs upward and medially for two to four segments, inserting on the spinous processes. This orientation produces greater capacity for rotation and abduction, in addition to extension.

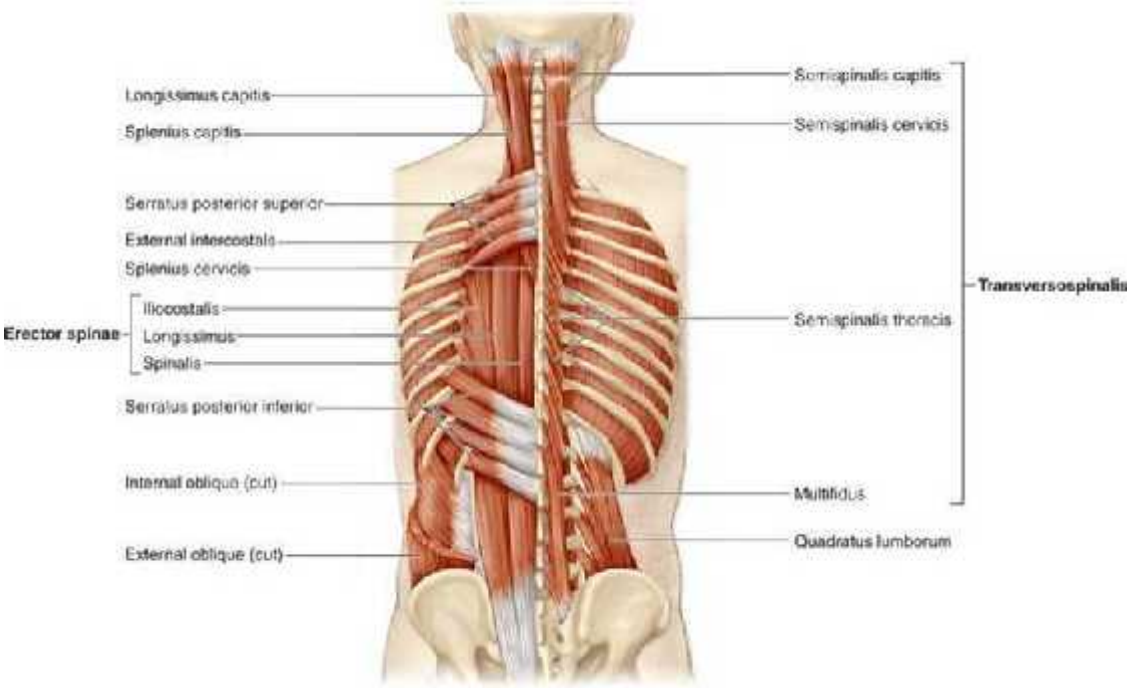
Quadratus Lumborum: This most lateral of the lumbar musculature originates on the iliac crest and iliolumbar ligament and runs obliquely to insert into the lowest rib and transverse processes of the upper four lumbar vertebrae.

Deep Muscles: The interspinalis are pairs of deep muscles spanning one segment on either side of the strong and elastic interspinous ligaments. The intertransversales, in the lumbar spine, consist of a pair of muscles on each side, spanning the transverse processes of adjacent vertebrae. Each side has dorsal and ventral slips.

Psoas Muscles: The psoas major, although usually thought of primarily as a

hip flexor, has a direct action on the vertebral column as it originates bilaterally from the lumbar vertebral bodies and posterior aspects of the transverse processes, thus providing the only muscle acting anterior to the sagittal axis. Paradoxically, however, the psoas is usually an inter-segmental extensor in the midlumbar spine, even as it flexes at the lumbosacral junction in the process of increasing lumbar lordosis. It is an important spine stabilizer in sitting and standing. Acting asymmetrically, the psoas may produce ipsilateral abduction concentrically or contralateral abduction resistance eccentrically to maintain coronal balance.

Fig. No. 5 Deep spinal Muscles



B. Extrinsic Muscles

Abdominal Musculature: There are four important abdominal muscles in spine function. The rectus abdominis is primarily a flexor, spanning the anterior abdomen from its origin on the pubic crest to its insertion on the anterior rib cage

between the fifth and seventh ribs. The obliquely oriented abdominal muscles are, from superficial to deep, the external oblique, internal oblique and transversalis abdominis, and may all act to produce rotation or abduction, as well as assisting both flexion and extension under different circumstances. The fibers of the external oblique run in an anteroinferior direction from attachments on the lower eight ribs to insert along the anterior rectus sheath and anterior wall of the iliac crest. The internal oblique fibers are almost perpendicular in direction to those of the internal oblique fibers. This muscle courses transversely only in its lowermost portion, with most of the muscle running anteriorly and proximally from its origins from the lumbo-dorsal fascia and anterior two thirds of the iliac crest. It inserts on the lower three ribs and rectus sheath anteriorly. The transversalis abdominis, the deepest muscle of the group, runs transversely like a horizontal girdle from the lumbodorsal fascia, anterior iliac crest, and inner surface of the lower six ribs. The main mass of the muscle inserts into the linea alba in the midline. It is probable that in the act of flexion, the abdominal muscles not only act to create a ventral movement, but also stabilize the spine posteriorly through their action on the lumbodorsal fascia.

Gluteal Muscles. The large muscles of the buttocks, chiefly the gluteus maximus, gluteus medius, and gluteus minimus, act variously as hip extensors and abductors. As such, they act as motor to the spinal “boom” in forward bending and twisting movements. They also provide the “spinal engine” for locomotion.

Posterior Thigh Musculature. Muscles attached to the ischial tuberosity, such as the hamstrings, are also strong pelvic extensors acting about the hip fulcrum. As such, they provide powerful assistance to the musculature of the buttocks in raising and lowering the pelvis. The hamstrings also provide efficient passive restraint on pelvic flexion when the knees are locked in extension. In the absence of active

contraction of the posterior thigh and spinal extensor musculature, the hamstrings are the inferior restraint providing the most efficient forward flexion.

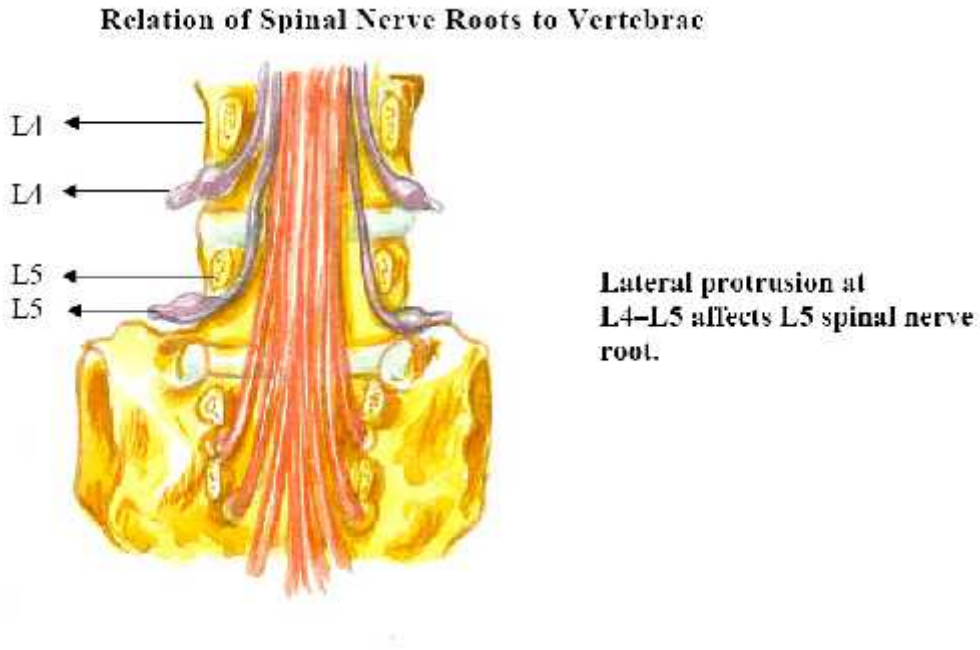
7. RELATIONS OF THE ROOTS OF THE SPINAL NERVES

The dorsal and ventral nerve roots pass through the subarachnoid space and coverage to form the spinal nerve at approximately the level of its respective intervertebral foramen. Owing to the apparent developmental rise of the spinal cord resulting from the delayed caudal differential growth of the lower parts of the vertebral column the course of the nerve roots becomes longer and more obliquely directed as one approaches the lower segments. Therefore, in the cervical region the nerve root and the spinal nerve are both posteriorly related to the same corresponding intervertebral disc, but because of the peculiarty of cervical nerve nomenclature, the nerve designation is one number greater than that of the disc. In the lumbar region, however, a different situation prevails.

The nerve roots contributing to the cauda equina travel an almost vertical course over the dorsum of one intervertebral disc to exit with the spinal nerve of the foramen one segment lower. Thus, in both the cervical and lumbar regions, dorsal protrusions of disc material affect the nerve root that is designated one number greater than that of designated one number greater than that of the offending disc, but not for a consistent anatomic reason.

Once the meningeal coverings blend with the epineurium, the nerve components become extrathecal. The actual point of this transition is variable but usually occurs in relation to the distal aspect of the dorsal root ganglion.

Fig. No. 6: Relation of Spinal Nerve Roots to Vertebrae



8. NERVE ROOT ORGANIZATION:

The macroscopic organization of the nerve root complex lateral to the thecal sac with regard to the take-off angle of the nerve root sleeve, the relative position of the motor and sensory bundles within the sleeves, and the position and size of the dorsal root ganglia are outlined below.

a. Nerve root sleeve angulation

The lumbar nerve root sleeves exit the thecal sac at mean angles of approximately 40°. The nerve root take off angle changes acutely at the first sacral root, which exits at an average angle of 22°. The lower sacral take off angles progressively decline.

b. Motor and Sensory Bundle Orientation

Intrathecally, the motor bundle of each nerve root is situated anteromedial to its sensory component. Extrathecally, the motor bundle lies directly anterior to its sensory counterpart.

c. Dorsal Root Ganglia Size

The size of the dorsal root ganglia varies with the vertebral level, increasing from the first lumbar to the first sacral level and decreasing in size thereafter.

d. Dorsal Root Ganglia Position

The mean length of the spinal root sleeve, as measured from its origin to the proximal margin of the dorsal root ganglion, also varies with the vertebral level, from as short as 6mm at the first lumbar level to 15mm at the second sacral level.

9. BIOMECHANICS OF THE SPINE

The spine is capable of ventroflexion, extension, lateral flexion and rotation. This remarkable universal mobility may seem at odds with the fact that its most essential function is to provide a firm support for the trunk and appendages. The apparent contradiction may be resolved when one realizes that the total ranges of motion are the result of a summation of limited movements permitted between the individual vertebrae and that the total length of the spine changes very little during its movements. The role of the musculature in the performance of the supportive functions cannot be minimized, as the disastrous scoliosis that results from their unilateral loss in a few motor segment units may attest.

The degree and combination of the individual types of motion described above vary considerably in the different vertebral regions. Although all subaxial-presacral vertebrae are united in a tripod arrangement consisting of the intervertebral disc and the two zygapophyseal articulations, the relative size and shape of the former and the articular planes of the latter determine the range and types of motion that an individual set of intervertebral articulations will contribute to the total mobility of the spine. In general, flexion is the most pronounced movement of the vertebral column as a whole. It requires an anterior compression of the intervertebral disc and a gliding separation of the articular facets, in which the inferior set of an individual vertebra tends to move upward and forward over the opposing superior set of the adjacent inferior vertebra. The movement is checked mainly by the posterior ligaments and epaxial muscles. Extension tends to be a more limited motion, producing posterior compression of the disc, with the inferior articular process gliding posteriorly and downward over the superior set below. It is checked by the anterior longitudinal ligament and all ventral muscles that directly or indirectly flex the spine. Also, the laminae and spinous processes may sharply limit extension. Lateral flexion is accompanied by some degree of rotation. It involves a rocking of the bodies on their discs, with a sliding separation of the diarthroses on the convex side and an overriding of those related to the concavity. The rotational component brings the anterior surface of the bodies toward the convexity of the flexure and the spinous processes toward its concavity.

Lateral flexion is checked by the intertransverse ligaments and the extensions of the ribs or their costal homologues.

Pure rotation is directly proportional to the relative thickness of the intervertebral disc and is mainly limited by the geometry of the planes of the

diarthrodial surfaces. The architecture of the disc, while permitting limited rotation between the bodies, also serves to check this movement by its resistance to compression. The consecutive layers of the annulus fibrosus have their fibers arranged in an alternating helical fashion, and rotation in either direction can be accompanied only by increasing the angularity of the opposing fibers to the horizontal, which in turn requires compression of the disc.

The entire vertebral column rotates approximately 90 degrees to either side of the sagittal plane, but most of this traversion is accomplished in the cervical and thoracic sections. It flexes nearly the same amount, using primarily the cervical and thoracic regions. Roughly a total of 90 degrees of extension is permitted by the cervical and lumbar regions, while lateral flexion with rotation is allowed to the extent of 60 degrees to both sides, again primarily by the cervical and lumbar areas.

10. THE INTERVERTEBRAL DISC

a. Tissue Structure and Function

The intervertebral disc is a specialized connective tissue designed to provide strength, mobility and resistance to strain. For its normal function it must possess elastic properties. A normal disc allows the spine to move in various directions and to resist axial load. The matrix of the intervertebral disc is able to fulfill these requirements through its very specialized collagen network and its highly concentrated proteoglycan-water gel. Any changes in the structure, and hence the mechanical efficiency, of the disc are likely to interfere with such functions, which are essential for the equalization and absorption of the various stresses placed on the vertebral column.

The proteoglycan gel of the nucleus, with its high swelling pressure and ability to maintain hydration under large external loads, resists compression, while the specialized weave of the collagen network acts in tension to restrain the proteoglycan and yet allow bending and torsion of the disc. The mechanical properties of the disc are therefore dependent on the interplay of these two components. In addition, although the disc has a relatively low cell density, cells are present and necessary for the continued renewal and replacement of the proteoglycans. Nutrition of these cells is essential for maintenance of the integrity of the disc matrix. Inadequate nutrition or accumulation of waste products could be one of the causes of disc degeneration. Since the intervertebral discs are large, avascular structures. Nutrients are supplied by diffusion and mechanisms other than diffusion the fluid pumping. Any disturbance in transport, nutritional supply or composition or highly activated enzymatic degradation may lead to mechanical dysfunction of the entire lumbar motion segment.

The intervertebral disc structure consists of three main parts: the outer annulus fibrosus, the inner gelatinous nucleus pulposus, and the cartilaginous end plates, which are interposed between the bony vertebral bodies and the disc material.

The annulus fibrosus is organised into lamellae of coarse collagen fibrils. These run obliquely to each other in alternating layers, which surround the nucleus pulposus. It has a banded appearance resulting from the intricate arrangement of these fibrous lamellae. The annulus is less hydrated than the nucleus, and the changes that occur with age are not as apparent. The distinction between annulus and nucleus, while pronounced in young individuals, is not sharply defined in adults. In the junctional area there is a gradual change from the more fibrous annulus to the more gelatinous nucleus.

Lumbar disc

Specimen showing
Conus medullaris with
Cauda equina

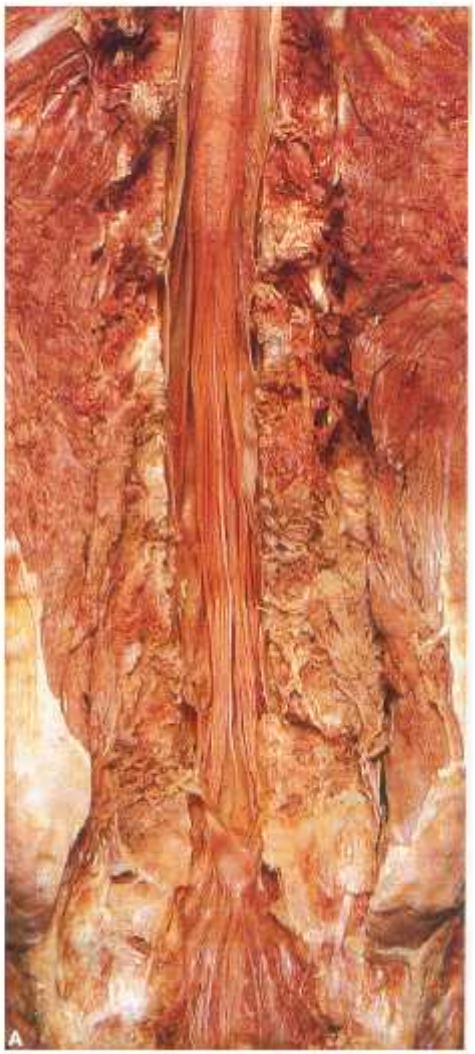


Fig. No. 7: Lumbar disc **Fig. No. 8: Conus medullaris with Cauda equina**

b. Pathophysiologic Mechanisms

The nucleus pulposus is the functional center of the disc, and when it loses its plasticity, and hence its load-bearing capacity, minor movements and loading may cause mechanical effects on the annulus, with the occasional result of annular ruptures and disc herniations. Disc herniation is a manifestation of disc degeneration. No ruptures occur in an annulus without the nucleus showing advanced structural changes.

The most widely accepted reason for disc degeneration is an insufficient nutritional state of the disc tissue. Blood vessels disappear from the disc at about the ages of 18 to 20 years. At the same age the first signs of degeneration can be seen. Reduced permeability of the vertebral end plate in connection with disc degeneration and age changes of the disc, are associated with impaired transport of solutes and waste products. The latter causes accumulation of lactate and other end products, and hence lowers the pH. This in turn may activate matrix-degrading enzymes. All these processes occur at similar times, after age 20 to 25 radiographic changes suggesting degenerated discs are rarely seen below this age, and low back pain complaints manifest themselves increasingly from this age over the next two decades of life.

c. Models of Changes in Nutrition and Morphology

(i) Fusion of Motion Segment:

Fusion immobilizes the fused segment and changes mechanical stresses in both the fused and the adjacent discs. The concentration of solutes fall with time in the fused segments after fusion was achieved. Consistent with the concentration fall in the fused segments, the activity in the adjacent discs increased. These changes suggest that metabolic activity is possibly triggered by spinal motion. There is also a large increase of lactic acid accumulation in the nucleus of the fused discs. Perhaps this occurs because in the fused area the blood supply to the end plate of the disc is gradually reduced, thus partially closing one route for movement of solutes out of the tissue and allowing the concentration of metabolic products to build up. In the discs adjacent to the fused segments, which presumably also undergo abnormal mechanical stress, the changes are seen in the opposite direction to those seen in the fused segments, and are more like those observed in the discs of trained (i.e., physically conditioned) subjects.

(ii) Prolapse:

The glycosaminoglycan content of prolapsed discs has been found to be lower, and the collagen content higher, than that of a normal comparable disc. The water content of prolapsed discs is also lower than that of normal discs. Whether the changes occurring are a result of proteoglycan loss or collagen increase after herniation, or whether prolapse follows changes in tissue biochemistry, is not known.

(iii) Scoliosis:

Scoliosis often develops during the adolescent growth phase of life and is frequently idiopathic. However, scoliosis may also occur secondary to inherited connective tissue disorders such as Ehlers-Danlos syndrome and Marfan's syndrome. In general, there is a decrease in glycosaminoglycan content of scoliotic discs and a proportional increase in collagen content. These changes in composition may result from alterations in the loading pattern on the spine because of the scoliosis.

(iv) Vibration:

The intervertebral discs occupy about one third of the lumbar spine, and one of their major functions is to act like shock absorbers, equalizing and distributing applied loads. Normally, during lifetime, discs are subjected to forces acting variously in compression, distraction, torsion, shear and vibration. It is the cells and their nutritional support system that enable the largest avascular structure in the body to function in a physiologically acceptable manner. Although the cells are inhomogeneously distributed and sparse, they nevertheless must continue to produce collagen and proteoglycan macromolecules, in order to maintain specific mechanical properties of the discs. Vibration is known to have deleterious effects on different microvascular systems in the body. Vibration can also affect the nutrition of the avascular lumbar intervertebral discs, which are critically dependent on highly

efficient microcirculation close to the vertebral end plate and the periphery of the annulus fibrosus.

(v) Smoking:

The efficacy of solute delivery from the capillaries, the capacity of the avascular disc bed, and the dimensions of the disc systems are factors of specific importance. This is particularly true in the case of the large human discs in which the balance between nutrient utilization and supply is precarious. Any loss in blood vessel contact or reduction in blood flow at the periphery of the disc could lead to nutritional deficiencies and a build-up of waste products.

Several factors may be of potential risk in developing blockage of capillaries or acting directly on capillary walls, inducing constriction and consequently affecting blood flow. One such risk factor is cigarette smoking. Smoking is also regarded as a potential risk factor for initiating low back pain.

Cigarette smoking has clearly been shown to affect the circulatory system outside the intervertebral disc, as well as cellular uptake rates and metabolite production within the disc. By reducing the transport of substrate into the disc and waste products out of the system, the inevitable consequence over a long period is deficient nutrition, leading to degenerative metabolic processes, disc dehydration, instability, and probably low back pain.

(v) Diabetes

As mentioned above, the microcirculatory system outside the disc is critical for the supply of relevant nutrients, as well as disposal of waste products from the disc. Any disturbance in the capillary network may lead to problems for the centrally located cells and inevitably lead to degenerative processes in the tissue. One risk factor they may change the arterial transport properties outside the disc system is

diabetes. Diabetes often leads to acceleration of atherosclerosis and consequently may induce impairment of circulation.

Consequently, a reduction in the blood flow and nutritional exchange area close to the intervertebral disc may lead to a breakdown of the disc tissue.

BIOMECHANICS OF THE INTERVERTEBRAL DISC

The internal composition of the disc has evolved to withstand great stresses through the liquid and elastic properties of nucleus and annulus acting in combination. The nucleus is distorted by compression forces, but being liquid in nature it is in itself incompressible. It serves to receive primarily vertical forces from the vertebral bodies and redistribute them radially in a horizontal plane. It is, therefore, the distortion of the annulus by the internal pressure of the nucleus that gives the disc its compressibility, and its resilience makes possible the recovery from pressure.

Were the nucleus pulposus simply a cavity filled with water, it would momentarily act in the same capacity, but the ability to maintain the appropriate quantity of fluid during the continual compression and recovery cycle would be lacking. It is this ability to absorb and retain relatively large amounts of water that is the unique property of the living tissue of the nucleus. It is known that the essential compound involved in this process is protein-polysaccharide gel, which through a high imbibition pressure will bind nearly nine times its volume of water. The hydrophilia is not a form of biochemical bonding, because a quantity of water can be expressed from the nucleus by prolonged mechanical pressure. This accounts for the diurnal decrease in the total length of the spine and its recovery in the supine position at night.

The annulus must receive the ultimate effects of most forces transmitted from one vertebral body to another. Since the major loading of the intervertebral disc is in the form of vertical compression, it may seem paradoxic that the annulus is best constructed to resist tension, but the nucleus transforms the vertical thrust into a radial pressure that is resisted by the tensile properties of the lamellae. Although the basic plan of alternating bands of fibers is one of the obvious sources of the tensile strength

of the annulus, this arrangement is not uniform with respect to the directions of the fibers or the degrees of resistance and reslience encountered throughout the annulus. The fibers generally become longer, and the angle of their spiral course becomes more horizontal near the circumference of the disc, for it is here that the shearing stresses of vertebral torsions would be most effective.

The disc is also “preloaded”. The inherent tensions of the intervertebral ligaments and the annulus exert a pressure of about 15kg, since this weight is required to restore the original thickness of the disc after the ligaments have been divided.

DISC DEGENERATION

Hult L.[34] in 1954 showed a linear increase in disc degeneration, to nearly 100 percent by the age of 59 years in workers performing heavy physical work.

Kelsey and White[35] in 1980 reported that the risk of being hospitalized for a herniated disc or sciatica was lowest in professional occupations and highest in manual workers and motor vehicle drivers.

VASCULAR FACTORS:

Some investigators have suggested that insufficient blood supply could be a significant causative factor in disc degeneration.

Kirkaldy W and associates[36] in 1988 delineated the natural aging process of the intervertebral discs from nuclear dehydration, through a series of inevitable changes. These degenerative changes might be accentuated in predisposed persons. With progressive degeneration, herniation of disc material causing nerve root compression may occur, generally between the ages of 30 and 50 years.

Holm[37] in 1993 suggested that changes in disc dimensions during prolonged exercise as well as under prolonged external load appears to have a dramatic and permanent influence on the transport of nutrients into the disc.

The ischaemic etiology was further supported by studies which showed an association between atheromatous lesions in the abdominal aorta and low back pain.

MECHANICAL FACTORS FOR PAIN:

Mixter and Barr[20] in 1934 propogated a mechanical understanding, wherein the herniated disc compresses the root causing a sciatica.

The spinal nerves are relatively well protected from external trauma from

surrounding structures. However, because they do not posses the same amount and organization of connective tissue sheaths as peripheral nerves, the spinal roots are particularly sensitive to direct mechanical trauma.

Smith and Wright[38] in 1958 showed the mechanical sensitivity of the affected nerves at the level of disc herniation.

DISC HERNIATION AND ITS TYPES

Weber[39] in 1983 expressed that, disc herniation was a collective term, to describe a process with rupture of annulus fibrosus and subsequent displacement of the central mass of the disc into the intervertebral space, common to the dorsal or laterodorsal aspect of the disc.

A herniation occurs in a lumbar intervertebral disc when a separate tissue fragment extrudes or sequestrates, through a tear of the annulus. Both a fissure and fragment appears to be required for prolapse to occur.

1. Types of disc herniation:

Mink[40] in 1989 has usefully described disc herniation as a

1. Simple herniated disc (subannular herniation) : a portion of the annulus fibrosus and the entire posterior longitudinal ligament are intact and contain the nuclear material.
2. Extruded herniation (subligamentous herniation) : the annulus is completely torn, but the posterior longitudinal ligament remains intact.
    a. Without migration.
    b. With migration.

In continuity with the disc space Without continuity with the disc space (sequestrated fragment)

3. Free fragment: The annulus and the posterior longitudinal ligament are torn, and the disc material lies free in the epidural space
    a. Without migration
    b. With migration

Its continuity with the disc Without continuity with the disc (sequestrated fragment)

2. Location of disc herniation:

Based on operative findings of the situation of the herniation in relation to neural root and/or thecal sac. Edgar M.B and Park W.M[41] in 1974 classified herniations as:

1. Central Herniations – lie in contact with and completely overlapped posteriorly by the dura - can affect several nerve roots in the cauda equina.
2. Intermediate or paramedian herniation – lie in contact with both dura and nerve roots - can affect nerve roots of the next caudal level
3. Lateral herniation – deform the nerve root sheath alone can affect the nerve root of the corresponding level.

Herniation with clinical consequence are most frequent between the ages of 30 and 50 years. The clinical situation resulting from lumbar disc herniation ranges from an asymptomatic condition to disastrous compression of the cauda equina.

The course varies from quiet onset, with development into a long lasting and disabling condition, to an acute painful attack of sciatica that also presents severe neurological signs that may improve without sequelae.

Clinically the diagnosis of disc herniation is based on history and physical examination findings and is supplemented by imaging studies.

Fig. No. 9 Types of disc herniation

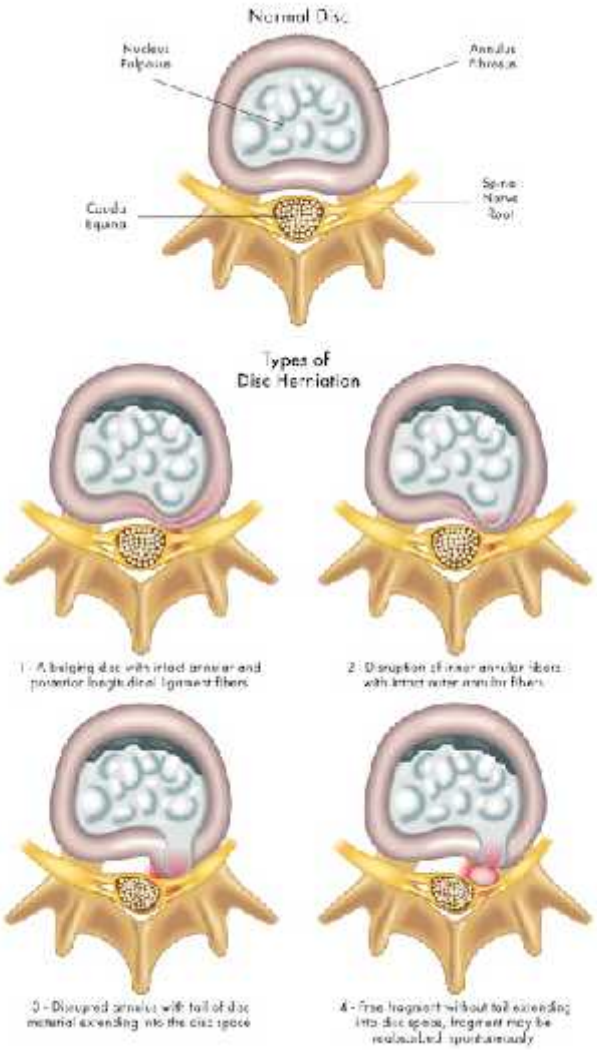
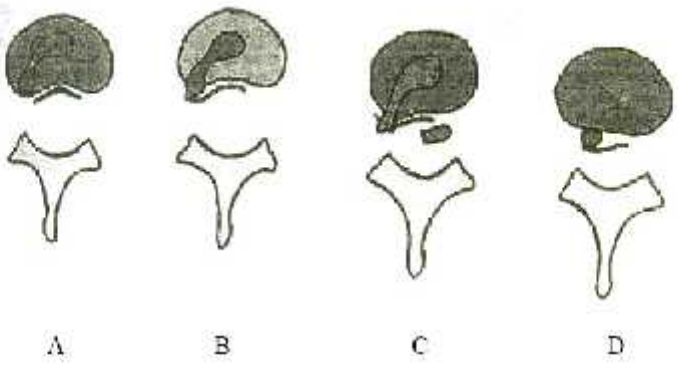


Fig. No. 10: Types of Disc Herniation



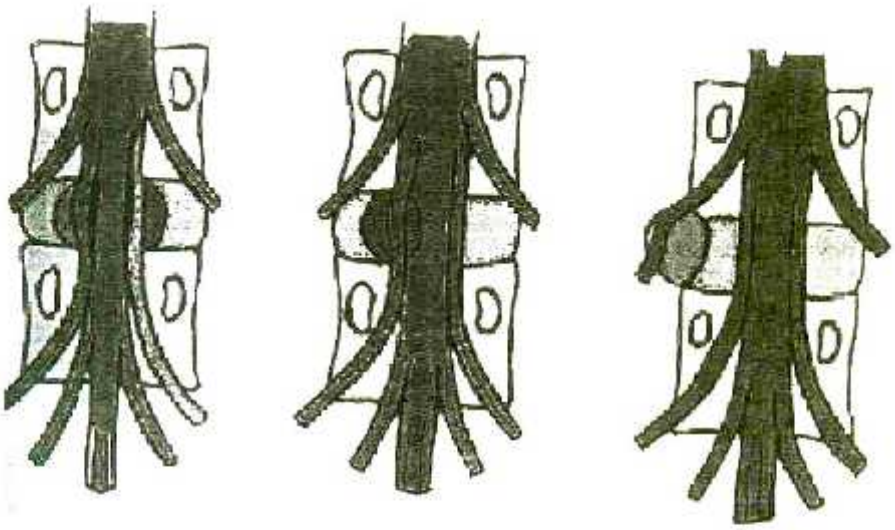
TYPES OF DISC HERNIATION

A Protrusion

B Extrusion

C – Sequestration without migration

D–Sequestration with migration



SITUATION OF DISC HERNIATION

A Central herniation

B Intermediate herniation

C Lateral herniation

CLINICAL FEATURES

In the clinical discussive analysis: the following factors are essential: the case history; the present pain with respect to localization, quality, variation and intensity ; change in spinal posture and mobility ; the nerve tension signs; and abnormalities in sensory, motor and reflex functions.

HISTORY:

Pain:

Pain is the dominant and most disabling symptom, in patients who have sciatica due to a ruptured disc.

Back pain:

Most patients with lumbar disc herniation, have low back pain as the earliest symptom. Often the patient recalls that, after periods of demanding physical activity or of seemingly benign but prolonged postures, deep boring pain appears in the lumbosacral area. The mechanical dull aching pain is made worse by standing, lifting and prolonged sitting, and is relieved by rest. The pain may last a few days and is characteristically intermittent in nature.

Radicular pain / Sciatica:

Pain, numbness and tingling sensation in the involved leg, are the most common symptoms of an acute herniated disc. The patient often describes a sharp, shooting/ lancinating pain, usually starting at the hip or proximal portion of thigh and ultimately has a radicular distribution, corresponding to that of the nerve root involved.

The onset of the leg pain may be insidious or may be sudden in onset, associated with a tearing or snapping sensation. Occasionally, the back pain may resolve at the onset of sciatica.

The pain is accentuated by manoeuvres that stretch the involved root. Also, increase in intrathoracic or intraabdominal pressure, such as coughing, sneezing, or the Valsalva manoeuvre, may increase the pain.

The sciatic pain may vary in intensity. It may be so severe that the patient will be unable to walk and will describe the back as “locked” or it may be a dull ache that increases in intensity with ambulation.

Sensory symptoms:

The sensory symptoms appear with far more frequent than do the motor symptoms. The most common symptom, following nerve irritation, is pain, in the form of paresthesias, hyperesthesia or hyperallegesia.

Motor symptoms:

During the initial stage of sciatica, patients are most concerned about sensory dysfunction and may not even notice motor deficits.

Infrequently, the patient may present with lower extremity weakness which may be disabling. This is more likely to occur in disc lesions involving the fourth and fifth lumbar spinal nerve roots.

Cauda equina syndrome:

Massive extrusion of nuclear material compressing the cauda equina, may produce partial or complete paralysis of both lower extremities, widespread sensory changes, abnormalities of bowel and bladder function.

PHYSICAL EXAMINATION:

The results of all clinical tests may differ. This reflects daily spontaneous fluctuation of symptoms, as well as inter observer variation.

O’connell[22] in 1951 classified the signs, in lumbar disc herniation as the

spinal signs, signs of root tension or compression and neurological signs.

Spinal signs:

Loss of normal lumbar lordosis and paravertebral spasm are usually seen during the acute phase of disease, occasionally in less acute situation the protective muscle spasm can be elicited, only when the patient is stressed by prolonged standing or forward flexion of the spine.

When acute sciatica is present, the patient usually has a list which has been termed sciatic scoliosis. When the disc herniation is lateral to the nerve root, the patient will list away from the side of the irritated nerve in an attempt to draw the nerve root away from the disc fragments. When the herniation is in an axillary position, medial to the nerve root, the patient may list towards the side of the lesion in an effort to decompress the nerve root.

Limitation of spine motion, is usually noted during the symptomatic phase of lumbar disc disease, particularly prominent in the sagittal than in the frontal plane.

With patient either in erect or prone position palpation, may evoke tender area in the midline, at the level of the disc lesion and also in paravertebral areas on the side of a nuclear extrusion.

Nerve tension signs:

Nerve irritation may be elicited by any method increasing tension on the nerve.

The straight leg raising test:

The passive straight leg raising test is the most commonly employed one. With the straight leg raising manoeuvre, the L5 and S1 nerve roots, move 2 to 6mm at the level of the foramina.

In an analysis of the diagnosis of the straight leg raising test (SLR Test), it was

noted that tension is realized within the nerve roots contributing to the sciatic nerve, at 35 to 70 degrees of elevation from the supine position. The test is performed with the patient supine and head flat or on a low pillow. One of the examiner's hand is placed on the iliac bone to stabilize the pelvis and the other hand slowly elevates the leg by the heel with the knee straight. Only when leg pain or reproduction of the patient's radicular pain occurs, the test is considered positive. Many variations of this test have been described, and all are useful, as long as they are performed and interpreted as described.

Neurologic examination:

A meticulous neurological examination often, but not always, yields objective evidence of nerve root compression. It suggests the level of disc herniation but is not conclusive in this regard. The involved nerve root, usually, is not completely involved and the neurologic findings may vary. There may be no objective neurologic findings because the involved nerve often remains functional.

To be significant, reflex changes, weakness, atrophy, or sensory loss must confirm with the rest of the clinical picture. The neurological findings in the lumbosacral nerve root lesions are compiled in the following table.

Clinical root syndrome	Sensory findings	Motor findings	Reflex changes
L4	Numbness over the posterolateral thigh, anterior knee and medial leg	Weakness and atrophy of quadriceps	Knee jerk diminished.
L5	Numbness over anterolateral leg, dorsum of foot, web of great toe.	Weakness of EHL, EDL and brevis, gluteus medius	Changes uncommon (diminished posterior tibial reflex)
S1	Numbness over lateral malleous, lateral foot, heel and web of fourth and fifth toes	Weakness of peroneus longus and brevis, gastronemius – soleus complex.	Ankle jerk diminished or absent.

Because, more than 95% of lumbar disc herniation occur at the L4-L5 or L5-S1 the neurological examination should focus on the L5 and S1 nerve roots.

Dysfunction of the L5 nerve root, typically results in no reflex changes, but does result in weakness of the great toe extensors and often dorsiflexion of the foot and sensory loss along the anterolateral aspect of the leg. Sensation is often reduced in the great toe and in the web space between the first and second toes.

Compression of the S1 nerve root, typically results in diminished ankle reflex, weakness of the plantar flexion of the foot and sensory deficits of the lateral foot, heel and web of fourth and fifth toes.

Macnab I.[42] in 1977 lists the criteria for the diagnosis of the acute radicular syndrome (Sciatica due to an herniated nucleus pulposus) as:

1. Leg pain (including buttock), is the dominant complaint when compared with back pain.
2. Neurological symptoms, that are specific (leg parasthesias in typical dermatomal distribution).
3. Significant straight leg raising changes Straight leg raising less than 50% of normal Bowstring discomfort Cross over pain.
4. Neurological signs: Weakness, wasting, sensory loss, or reflex alteration. (At least two of four).

Three of four of these criteria must be present, the only exception being, young patients who are very resistant to the effects of nerve root compression and thus may not have neurological symptoms (criteria 2) nor signs (criteria 4)

INVESTIGATIONS

A. Myelography

Up until recently, the gold standard in the diagnosis of disc herniations, has been the Myelogram. Bell and associates[43] in 1983, reported the largest series comparing computed tomography with metrizamide myelography in the diagnosis of surgically proven herniated discs and spinal stenosis.

Recently, Albeck and associates[44] in 1994, in a controlled comparison of myelography, computed tomography, and magnetic resonance imaging in clinically

suspected lumbar disc herniations indicated that computed tomography or magnetic resonance imaging should be the first choice of imaging in patients with suspected lumbar disc herniation.

B. Computed tomography (CT)

Major advantages of computed tomography and magnetic resonance imaging over myelography, are their ability to visualize lateral pathology, their non invasiveness and their less radiation exposure for patients and radiologists.

The importance of correlating, findings in the various imagining modalities with clinical symptoms has been emphasized in several studies. Wiesel and associates[45] in 1984, performed lumbar CT Scans in 52 asymptomatic subjects. The overall incidence of CT abnormalities was 37% and was more common in persons over 40 years of age.

C. Magnetic resonance imaging (MRI):

Magnetic resonance imaging offers increased soft tissue resolution and allows evaluation of lateral recess pathology, in addition to visualizing the thoraco lumbar region for possible spinal tumors. Modic M.T and coworkers[46] in 1986 investigated the accuracy of MRI, metrizamide myelography (MM), and CT in lumbar disc disease. Their studies showed that MRI was more accurate than MM (82.3% versus 71.4%) and was equal to CT (82.3% vs. 83%) in diagnosis of disc herniations. They concluded that the combination of MRI and CT was equal in diagnostic accuracy to the combination of CT and MM (92.5% vs. 89.4%). However, because MRI and CT are non invasive, their advantage to the patient is obvious.

More recently, Boden and colleagues[47] 1990, performed lumbosacral MRI scans on 67 asymptomatic subjects. They reported findings suggesting compressive

pathology in approximately one third of the subjects studied. These reports emphasize the need for correlation of neuroradiologic findings with clinical symptoms and signs and this is the first step in avoiding surgical complication and failed back surgery syndromes.

Fig. No. 11: Myelograms

Myelogram showing indentation of right L3-L4 and at L4-L5 level

Myelogram showing non-filling of right S1 nerve root suggesting large paramedian herniation

Fig. No. 12: MRI Axial views Disc bulge L4-L5 and L5-S1

MRI-Diffuse disc bulge at L4-L5 causing compression on the thecal sac and bilateral neural foramina

MRI- Central disc bulge with annular tear at L5-S1 causing compression on the thecal sac

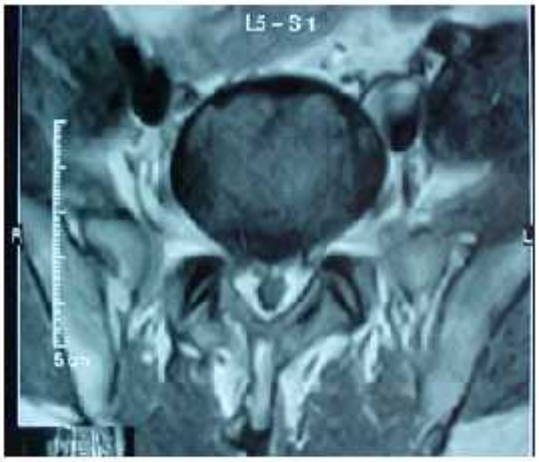


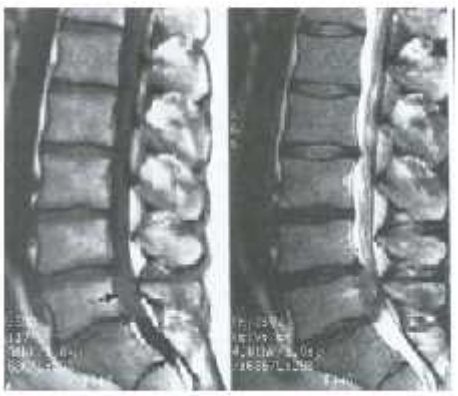
Fig. No. 13: MRI Sagittal views Disc bulge L2-L3, L3-L4 and L5-S1

Mild disc bulge at L2-L3 and L3-L4 level
Diffuse disc bulge at L4-L5
Schmorl's node at L4 vertebra

MRI - Disc bulge at L5-S1

Fig. No. 14: L5-S1 central disc herniation

Sagittal and axial MRI images showing disc dessication and central disc herniation causing thecal sac compression, at L5 S1 level



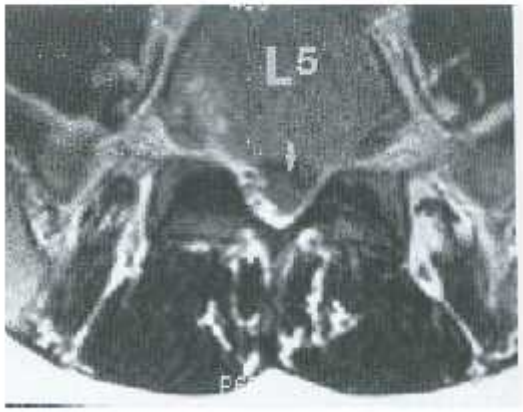


Fig. No. 15: Flexion and Extension view L-S Spine

MANAGEMENT

"Decision making is …. Something, which concerns all of us, both as makers of the choice and as the sufferers of the consequences."

D. V. LINDLEY

The diversified symptoms and the unpredictable course of lumbar disc herniation should be a warning against hasty and uncritical acceptance or interpretation of the results of the treatment. Some patients require surgical treatment on the other hand, conservative treatment modalities must be considered the mainstay of rational treatment for the well-motivated patient with herniated discs, even when considering the cost effectiveness. Most of the patients benefit from conservative treatment. However, current systems of therapeutic conservative intervention have little influence on the natural course of the disease process. The essential thing is the therapist and the patient is fully aware of the aims of the treatment. Patients who for a longtime are incapacitated with back pain or sciatica as a result of disc herniation tend to develop mental distress that may increase the disability and create social maladjustment. Therapeutic measures should always include elements of indulgence and empathy.[24,25,48,49]

The choice of treatment should be based on principle of parsimony. Results of the treatment are difficult to evaluate. Successful treatment outcome is based on strict selection of patients, which always depends on the attitude and personal experience of the therapist.

Non-operative treatment

The attitude towards symptomatic treatment should in principle be ambiguous. It should only be resorted to after uncompromising scrutiny of the clinical situation and interpretation of the symptoms. There is always a danger of being seduced by the cheap effects of symptomatic treatment, which may even prevent the unveiling of the essence of the ailment. The aim of symptomatic treatment is at best to help the patient to cope better with pain and maintain the habitual pattern of social existence. There are overwhelming varieties of treatments for back pain; unfortunately few have been evaluated scientifically. In addition, the natural history of disc disease is characterized by exacerbations and remissions with eventual improvement regardless of type of treatment.[24, 50,51,52,53]

Bed rest

The simplest treatment for acute back pain is rest. Rosenthal reported that 2 days of bed rest were better than larger period. In any case more than 2 weeks of rest is detrimental. Biomechanical studies indicate that lying in Semi-Fowler's position (on the side with the hips and knees flexed) with a pillow between the legs should relieve the pain and pressure on the disc and nerve roots. When confined to bed some patients report a temporary increase in back and radicular pain and alternating rest and ambulation is a solution.

Medication

Pain relief in the initial acute stage is important both for the comfort of the patient and for the ability to perform an examination. Simple NSAIDs are the drug

of choice. In case of severe pain, the addition of neuroleptic or psychoactive drugs may be useful.

Anti-depressants are not indicated in acute attacks, but they may reduce the need for analgesics in patients with chronic pain.

Patients should be encouraged to begin exercises soon after the pain subsides. Isometric abdominal and lower extremity exercises should be started to improve the balance. Endurance is considered more important than maximum strength. Activities of cardiovascular endurance training can be incorporated during the recovery period. As the most substantial strength deficit is in the trunk extensors, these muscles should be given attention, even with eccentric exercises. There is a specific role for medical exercise therapy, which is a carefully progressed regimen in which the grading of exercises makes it possible to start treating the patient at an early phase of disc injury.

This is obtained through methods of deloading, choosing exercises and starting positions that ease pain, but at the same time including training for stabilizing coordination, mobility, endurance and strength. Through intermittent pressure, the nutrition of the disc is supposed to be stimulated. Sequence training in groups is applied, with as well as without conventional equipment, with exercise progressing to stimulate daily activity. There is no evidence that physical activity prevents relapses after radicular symptoms, but such activity may improve the results after conservative or surgical therapy. Training should be related to function and simple to carry out. Group exercises in the form of “Back-school” concept can provide patients with mutual inspiration and motivation. Outdoor training might be preferred. Back school education must also consider education in proper posture and body mechanics, which are helpful in returning the patient to the usual level of activity after the acute episode,

is eased.[52,53] Both massage and the use of warm and cold applications can be adjuvant measures. They may achieve some muscle relaxation and provide a comfortable feeling.

Traction therapy is frequently utilized for acute and chronic sciatica. It can be both active and passive. It may be difficult to assess whether traction simply increases the effectiveness of bed rest or is effective by itself. Positive changes of neurological deficits are found concomitantly with pain relief after autotraction.

Some modalities of electrotherapy may be of interest. Transcutaneous electrical nerve stimulation (TENS) is found to provide efficient short-term analgesia but this treatment is inappropriate for longer periods. Acupuncture may give temporary pain relief and reduce consumption of analgesics. According to general clinical experience, short wave and ultrasound therapy are contraindicated.[52]

Spinal manipulation should be avoided in patients with disc prolapse because of the risk of damage associated with manipulation and lack of evidence of its positive effects.

One of the greatest problems for both the patient and the therapist is to know how hard to push themselves in the presence of pain and its attendant threatening complications. The illness behaviour component of a patient's disability is essential, even in relation to the underlying presumed physical trouble. According to principles of Fordyle, a behavioural approach seems to be most promising. The ergonomic assistance should be provided. Keeping people at work is the most effective treatment.

Epidural steroids

The epidural injection of a combination of a long-acting steroid with an epidural anaesthetic is an excellent method of symptomatic treatment of back and leg pain from discogenic disease and other sources. Most of the studies show 60-85% of short-term and 30-40% of long-term good results.

The local effect of steroids has been shown to last atleast three weeks at a therapeutic level. Best results are obtained in patients with subacute or chronic leg pain with no prior surgery. Worst results are in patients with motor or reflex abnormalities. A negative myelogram or MRI is associated with a better result. Epidural steroids is not a cure for disc prolapse but it provides a prolonged pain relief compared to analgesics. The factors associated with poor outcome are low education levels, smoking, lack of employment, constant pain, sleep disruption, non-radicular symptoms, prolonged duration of pain, change in recreational activities and extreme values on psychological scales.[24,25]

The drugs used are Methyl Prednisolone (Depo-Medrol) and dosage is 80-120 mg. The anaesthetics may be lidocaine or bupivacaine. Current protocol is to inject the patient three times at a 7-10 day intervals.[24]

Contraindications

Presence of infection, neurological disease, haemorrhage or bleeding diathesis, cauda equina syndrome and a rapidly progressing neural deficit.

Complications

- Failure to place the drug in epidural space L2 - S1. Use of fluoroscopy decreased the failure rate.
- Inadvertent penetration of dura and spinal anaesthesia.
- Transient hypotension, fascial flushing, difficulty in voiding, severe parasthesias, cardiac anginal headache and transient hypercorticoidism.

Kushner and Olson reported retinal haemorrhage in several patients who had epidural steroid injection for chronic back pain. They recommended careful consideration of this problem in bleeding disorders and who have only one eye. The total complication rate in most of series is about 5%.

Operative treatment

If non-operative for lumbar disc disease fails, the next consideration is operative treatment. Before this step, Surgeon must be sure of the diagnosis. The patient must be certain that the degree of pain and impairment warrants such a step. Both the surgeon and the patient must realize that disc surgery is not a cure but may provide symptomatic relief. It neither stops the pathological process that allowed the herniation to occur nor restores the back to a normal state. The patient must still practice good posture and body mechanics after surgery. Activities involving repetitive bending, twisting and lifting with the spine in flexion may have to be curtailed or eliminated. If prolonged relief is to be expected, then some permanent modification in the patient's life style may be necessary. The key to good results in disc surgery is appropriate patient selection.[24,26,54,55,56]

The general indications for disc surgery are:

- Unilateral leg pain extending below the knees that have been present for at least 6 weeks.
- The pain should have been decreased by rest, anti-inflammatory medication or even epidural steroids but should have returned to the initial levels after a minimum of 6 to 8 weeks of conservative care.
- Cauda equina syndrome due to central disc prolapse causing bowel or bladder disturbances. This is the absolute emergency indication for surgery.
- Disc prolapse with progressive neurologic deficits either motor or sensory.

In all patients subjected to surgery, patients with back pain should have clinical signs of sciatic irritation and possibly objective evidence of localizing neurological impairment. CT, MRI or myelography should confirm the level of involvement consistent with the patient examination. [11,24,25,57,58,60,61]

Patients with predominant back pain may not be relieved of their major complaint i.e. back pain. In Spangfort review of series of 2504 lumbar disc excisions about 30% of the patients complained of back pain after surgery. Failure to relieve sciatica was proportional to the degree of herniation. The best results of 99.5% complete or partial pain relief were obtained when the disc was free in the canal or sequestrated. In complete herniation or extrusion of disc material into the canal resulted in complete relief for 82% of patients. Excision of only bulging disc resulted in complete relief in 63% and removal of normal or minimally bulging disc resulted in complete relief in 38%, which is near the stated level for the placebo response. Likewise, incidence of persistent back pain after surgery was inversely proportional to the degree of herniation.

In the study of Dvork et al (1988) the operative criteria have been used for disc herniation which were19:

- Presence of a radicular radiation and/or antalgic attitude.
- Positive SLR < 450 and/or crossed SLR < 600.
- Two of the following neurological signs – Hypoalgesia, paresis, depressed or absent reflexes.

In their retrospective study they have divided the indication into justified 65% and unjustified 35%. They have not included radiological findings in the selection of patient. They found that so called justified reason for disc herniation does not necessarily imply good results as there was no statistical difference in long-term follow up between these two criteria.

Machemson (1993) proposed the indication of surgery for disc herniation and confirmed the utility of American Academy of Orthopaedic Surgeons recommending for intervention. [11,61]

- Functionally incapacitating pain in the leg extending below knee within a nerve root distribution.
- Nerve root tension signs (positive SLR) with or without neurological abnormalities fitting into radiculopathy.
- Failure of clinical improvement after 4 to 8 weeks of conservative treatment.
- Conforming image study – Abnormal myelogram, CT scan or MRI – correlating to physical signs and distribution of pain.

The criteria of Indian studies also varied widely:

Nagi et al (1985) suggested the following criteria;[62]

• Accentuation of symptoms with cough or sneezing.

• Position of comfort (Flexion at hip and knee).

• Spinal tenderness.

• Selective restriction of spinal movements.

• Positive SLR test.

• Conforming to radiological findings.

Gupta et al (1989) selected the patients for surgery. These were the patients who did not obtain relief of back and leg pain despite prolonged trial of conservative treatment, in whom neurological deficit could not be reversed and in whom symptoms and signs were conforming to radiological findings.[63]

The criteria for selection of patients developed by American Association of Neurological Surgeons and American Academy of Orthopaedic Surgeons (1993) include failure of extended conservative therapy, an abnormal myelogram, CT scan or MRI demonstrating nerve root compression – consistent with patient's symptoms and signs. Conformity of radicular pain to physiological dermatomal or sclerotomal pattern and one or more of following: sensory, motor loss or DTR abnormality in corresponding segments.

Finesson BE (1995) suggested four indications for surgery.[64] These were:

1. Intractable pain
2. Progressive worsening of neurological deficit
3. Intractable recurrence of pain
4. Cauda equina syndrome

   (1, 2, and 3 are relative indications).

From above it is evident that there are significant differences in indications for surgery. Even studies who are mentioning the functional outcomes have not explained the various indications for operations clearly.

According to Machemson, an international and national comparison of frequency of surgery may indicate that surgery performed is 2-4 times more often in United States. Upon reviewing the original history, physical examination and diagnostic studies, as many as 50% of patients with failed back syndrome are found not to have met the accepted criteria for primary surgical procedure. In these patients even if criteria for reoperation are met, the probability of successful outcome is small.[11,62]

In the present circumstances, we agree with Frederick A Sime one's view – usually the indication for surgical excision of herniated disc are definite but at times decision requires judgment. Patient with an advancing neurological deficit who have not responded to bed rest require surgery and when appropriate neuroimaging shows that clinically implicated disc is clearly herniated. Patients with advanced neurological deficit e.g. bowel and bladder movement were intervened early.[27]

A philosophy with reference to treatment of less afflicted patients, surgery is considered in well-motivated individuals who have responded incompletely to non-operative therapy and who remain unable to perform activities important to them. They must be willing to accept a less than perfect result and also understand that larger interval of bed rest and non-operative therapy might ultimately be effective. They should be aware of risk of operation and weigh these against a chance of prompt relief. The lack of response to non-surgical treatment is not the sole indication for surgery.

General principles of disc surgery

Most of the disc surgeries are performed with the patients under general endotracheal anaesthesia, although local anaesthesia has been used with minimal complications. Patient positioning varies with operative techniques and surgeon. Most commonly used are prone position, modified kneeling position, knee-chest position. Any position should allow the abdomen to hang free, minimizing epidural venous dilation and bleeding.

A headlamp allows the surgeon to direct light into the lateral recesses where a large proportion of surgery may be required. The addition of loop magnification also greatly improves the identification and exposure of various structures. Some surgeons also use the operative microscope to further improve the visibility. Operating microscope provides view to the assistant. Confirmation of the proper level is necessary. This can be achieved by preoperative marker film or per-operative fluoroscopy. Marker film should be obtained in such a way that marker should be placed with the patient in same position as that during surgery so as to avoid misplacement during different positions. Care should be taken to protect neural

structures. Epidural bleeding should be controlled by bipolar electrocautery. Any sponge pack or cottonoid patty placed in the wound should extend to the outside. Pituitary ranguers should be marked at a point equal to the maximum allowable disc depth to prevent accidental biopsy of viscera or aorta. Considerable research has gone into the technique to prevent epidural fibrosis. Hayland et al noted dense fibrous connective tissue about previously operated nerve roots. They also found fibrillar foreign material within the scar in 55% of patients. This finding should remind the surgeon to minimize the use of cotton patties. The placement of autogenous fat appears to be a reasonable although not foul proof or complication free technique of minimizing post-operative epidural fibrosis. Its role is well debated. Commercially available products may reduce scar volume, but clinical benefits remain uncertain.

It is proved by Spengler in 1981 that limited discectomy through fenestration at the level of disc prolapse is sufficient. There is no need for complete removal of disc and disc curettage. Complete removal of disc causes collapse of disc space which triggers degenerative changes in the apophyseal joints at a later date.[11,24,62,63]

Surgical options

The principal goal of surgical intervention is to relieve neural compression and hence radiculopathy while minimizing complications.

Options include:

- Posterior approach: Limited laminotomy (fenestration) with disc fragment excision or microsurgical laminotomy with disc fragment excision.
- Anterior approach with or without interbody fusion.

- The percutaneous approach: Arthroscopic, endoscopic suction or laser discectomy.

Posterior approach

Although this procedure may be performed under spinal or local anaesthesia, controlled GA with endotracheal intubation is generally preferred. Cautions to be taken while kneeling position is used.

- Avoid pressure on the eyes.
- Avoid neck extension, especially in older patients.
- Avoid abduction of the shoulder, this can cause a brachial plexus lesion.
- Watch pressure points, especially the ulnar nerve at elbow.

Microsurgeons believe that surgical technique can be improved with the assistance of the magnification and illumination provided by the microscope. Surgeons who use loupes for fragment excision believe that this technique is more expeditious. Most of the surgeons agree that, for teaching purposes, the microscopic technique is a better tool. Regardless of the technique selected, however, the procedure and the results are essentially same.[24,64,66,67,68]

After the fenestration has been accomplished enough laminar bone should be removed to ensure visualization of the lateral border of the nerve root. Sometimes when the interlaminar space is narrow as is the case in L3-L4 disc space or L2-L3 disc space, there requires a removal of medial edge of superior facet of the anatomical segment below. Care should be taken to preserve the mechanical integrity of facet and

not to excise more than half of the pars interarticularis so as to minimize chances of creating instability.[26]

Attempts to find the lateral border of the lumbar nerve root have potential pitfalls. The first problem is a nerve root that has been displaced laterally by an axillary disc herniation. Second pitfall is posterior displacement of a nerve root by a large disc herniation, which places the nerve root in jeopardy when the ligamentum flavum is opened. It is important to remove all offending disc material, not to miss any extruded or migrated disc fragments and not to leave behind osteophytes encroaching the nerve root.

It is important to be aware of root anomalies, which by their nature reduce nerve root mobility. A small disc herniation can cause major sciatica in these patients. At surgery, nerve root is immobile, which may lead to difficulty in reaching the floor of the canal and the disc lesion. There is no uniformity of opinion on how much disc to remove. Williams proposed that only the ruptured portion be removed. Spengler and Hudgins suggested limited disc removal. Historically, it was recommended that as much disc material be removed as possible with inclusion of curettage of end plates. We in the study used a middle path approach where we have removed the extruded disc and removed the real or potential loose disc material from the interspace. Use of free fat over the dura may make entry into the spinal canal easier if a subsequent operation for recurrent becomes necessary.[24,25,26,64,67]

Technique and results

Make a midline incision 5-6 cm long, centered over the interspace where disc herniation is located. Incise the lumbosacral fascia, supraspinous ligaments, and then

by subperiosteal dissection, strip the muscles from the spinous processes and lamina of these vertebrae on the side of the lesion. Retract the muscles with a self-retaining retractor or with the help of an assistant and expose one interspace at a time. If C-arm is available verify the level. Secure hemostasis with electrocautery, bone wax and packs. Leave a portion of each pack completely outside the wound for ready identification. Denude the lamina and ligamentum flavum with a curette. Commonly L5-S1 interspace is large enough to permit the exposure and removal of a herniated nucleus pulposus without removal of any bone. If not remove a small part of the inferior margin of the above lamina.

Thin the ligamentum flavum using a pituitary ronguer to remove the superficial layer. Detach the ligamentum from its cephalad or caudal laminar attachment using a small curette. Curette should be directed posteriorly to avoid the dural laceration. With Kerrison ronguers, remove the ligamentum flavum laterally and inferior portion of lamina as required. Keep the ronguers in direction parallel to the direction of nerve root to minimize the risk of root injury. Lateral shelving portion of the ligamentum flavum should be excised often with a portion medial inferior facet to gain access to the lateral aspect of the nerve root. Retract the nerve root medially so that underlying extruded disc fragment or bulging posterior longitudinal ligaments can be seen. Occasionally nerve root adheres to the fragment or to the underlying posterior longitudinal ligament, which requires careful blunt dissection. Take care to minimize packing of cottonoids about the nerve root. Cotton pattices may sometime displace the disc fragment from view. If an extruded fragment is not seen, carefully palpate the posterior longitudinal ligament and seek a defect or hole in the ligamentous structure. A microblunt hook can be used for this. If no obvious

abnormality is defected, follow the root around the pedicle or even outside the canal in search of fragments that may have migrated far laterally. Additional searching in the root axilla helps ensure that fragments that have migrated inferiorly are not missed. If the herniated fragment is especially large, it is much better to sacrifice a portion of facet to obtain a more lateral exposure than to risk injury to root or cauda equina lesion due to excessive medial retraction of the dura.

If the fragment is very large as with cauda equina lesions typically, a bilateral fenestration and piecemeal removal of disc fragment should be done. If the disc cannot be teased from under the root make a cruciate incision in the disc laterally, gently remove the disc fragments until the bulge has been decompressed to allow gentle retraction of the root over the defect. [24,25,26,67]

If herniation is upward or downward, further removal of bone from the lamina and facet edges may be required. Loose fragments should be lifted out carefully by suction, hook or pituitary forceps. If the ligament is intact incise in a cruciate manner and remove the loose fragments. Remember that the anterior part of the annulus is adjacent to the aorta, venacava or iliac arteries and veins and one of these structures can be injured if one proceeds to deeply. When placing the instruments into the disc space do not penetrate beyond a depth of 15 mm to avoid injury to the anterior viscera. Additional fragments usually migrate medially beneath the posterior longitudinal ligament but outside the annulus and can easily be missed. Forcefully irrigate any loose fragments from the disc space using a syringe with a spinal needle placed into the disc space under direct vision until no fragments are returned with the irrigating solution. Close the wound with absorbable sutures in the supraspinous

ligament, subcutaneous tissue and skin closed. Staples are avoided for patient comfort.

Neurological function is closely monitored after surgery. The patients is allowed to turn in bed at will and to select a position of comfort, such as a Semi-Fowler's position. Pain should be controlled with oral medication. Antibiotics are 3rd or 2nd generation cephalosporins and one of the aminoglycoside for 3 days. Muscle relaxants can be used to assist voiding. The patient is allowed to stand with assistance on the evening after the surgery to go to the bathroom. Discharge is permitted when the patient is able to walk and void. Currently most of the patients are discharged within 24 hours of surgery. Sutures of skin are removed after 12 days of surgery. Isometric abdominal and lower extremity exercises are started. The patient is instructed to minimize sitting for long time and sitting and riding in a vehicle. Increased walking on a daily basis is recommended. Lifting weight, bending and stooping are prohibited for first 6 weeks. As the patient's strength increases, gentle isotonic leg exercises are started.

Complications of Surgery

The complication are listed here are:

	Incidence %
• Cauda equina syndrome	0.2
• Thrombophlebitis	1.0
• Pulmonary embolism	0.4
• Wound infection	2.2
• Pyogenic spondylitis	0.07
• Postoperative discitis	2.0
• Dural tears	1.6
• Nerve root injury	0.5
• CSF fistula	
• Laceration of abdominal vessels	
• Injury to abdominal viscera	
• Missed pathological process	

Spangfort series of 2503 open disc excisions lists a postoperative mortality of 0.1%, a thromboembolism of 1.0. Rish in a more recent report with a 5 year follow up noted a total complication rare of 4% in a series of 205 patients. Major complication in his series was worsening neuropathy postoperatively. The presence of a dural leak or tear results in the potentially serious problems of pseudomeningocele, CSF leak and meningitis. Eismont, Wiesel and Rothman suggested five basic principles in the repair of these leaks.[24,29]

- The operative field must be dry, unobstructed and well-exposed.

- Dural suture of 4.0 or 6.0 with a tapered or reverse cutting needle is used in either a simple or running locking stitch. If the leak is large or inaccessible a free fat graft or fascial graft can be sutured to the dura. Fibrin glue applied to the repair also is useful but will not seal a significant leak.
- All repairs should be tested by using the reverse Trendelenburg position and Valsalva maneuvers.
- Paraspinal muscles and overlying fascia should be closed in two layers with non-absorbable sutures used in a watertight fashion. Drains should not be used.
- Bed rest in the supine position should be maintained for 4 to 7 days after the repair of lumbar dural defects. A lumbar drain should be placed if the integrity of the closure is questionable.

The development of headaches and a stormy postoperative period should alert one to the possibility of an undetected CSF leak. This can be confirmed by MRI studies.

Fibrin glue application

Mix 20,000 U of topical thrombin and 10 ml of 10% calcium chloride. In another syringe, draw 5 U of cryoprecipitate and inject equal quantities of each into the dural repair or tear. Allow the glue to set to the consistency of “Jelly”. Dural repairs can be augmented with this glue.

Free fat grafting

It should be used when the dura is opened or laminar defect is small. If used for large laminar defects, it might cause cauda equina syndrome.

Special situations with herniated disc

1. **Foraminal disc herniation**

Because of advent of CT and MRI foraminal disc prolapses and far lateral disc herniation syndromes are now recognized. However, we have not included these cases in our study. Most of the foraminal disc herniations are found in L4-L5 space in old individuals causing compression over L4 root. This fragment of disc should be removed through an approach lateral to the pars interarticularis.[24,54]

2. **Disc herniation with spondylolisthesis**

Patients with spondylolisthesis may experience disc rupture resulting in an acute radicular syndrome. The vast majority of disc prolapses occur at the level above the listhesis. On rare occasions disc prolapse can occur at same level as the slip. For former lesion simple disc excision is enough. For later lesion discectomy should be accompanied by a stabilization procedure.[24]

3. **Disc polapse with spinal canal stenosis**

Stenosis can occur in central canal or in the lateral zones. It can be mild symptomatic or asymptomatic that can suddenly convert to a major disability when a disc prolapse occurs. Investigators are somehow inconclusive in these patients. For asymptomatic stenosis simple excision of disc is enough. For symptomatic patients formal decompression precedes disc excision. One should be aware of the occasional existence of intracanal facet cysts, which may mimic a herniated disc and/or spinal stenosis in elderly patients.[24,46]

Follow up treatment

Sutures are removed at 12 days. Isometric abdominal and lower extremity exercises started from 2nd week. Between 4 to 6 weeks back school training restarted or started, provided that pain is minimal. Lifting, bending and stooping are gradually

restarted after 6th week. Increased sitting are allowed as the time permits and long trips are avoided for first 4 to 6 weeks. Lower extremity strength is increased from 8 to 12th week. Patients with jobs that do not require bending are allowed to return to work after 2 to 3 weeks. Patient with jobs requiring prolonged sitting are allowed to return to work after 6 weeks. Patients with heavy labour and prolonged driving are allowed to return to job after 8 weeks and are asked to modify their jobs. Patients doing exceptionally heavy manual labour are asked to modify their job profile permanently to a lighter occupation. Keeping the patient out of work beyond 3 months rarely improves recovery or pain relief.

Functional outcome

Lumbar discectomy is one of the most common operations performed by orthopaedicians. To assess objectively, the results of lumbar disc surgery, a literature search was conducted for common criteria in measuring the outcome. None was found. Interestingly, the results of lumbar disc disease present a challenge to surgeons. Dissimilarity among the population undergoing surgery compared the problems of wide variability in analyzing results. This subjective and objective observation and purposed implication from data assembled tends to confuse rather than illuminate. Clearly there is a need for simple systematic protocol for analyzing results of lumbar disc disease. Outcome of few reference studies with different criteria for evaluation have been explained below.[24,26,69,70]

Loon's criteria

"Excellent" results have no back or radicular pain and are able to perform all occupational and recreational activities. "Good" indicate minimal pain and slight restriction. "Fair" implies significant pain and restriction or no response to treatment. "Poor" means patient has major impairment or is further compromised by treatment.

Some authors express observation essentially in same manner with same category responses differing only in name i.e. complete relief of pain, partial relief, no relief or pain worse.[71]

Joel N Abramovitz

Categorized patients into three groups, good, fair and poor, A "good" outcome was defined as a situation where patient has returned to premorbid level of activity and where he was not limited by residual symptoms and patient was not taking narcotic medication. A "fair" outcome was defined as a situation where patient had not returned to work or was taking narcotic medication but had improved after surgery. A poor outcome was defined as a situation where patient has not improved.63 His results in 108 patients were recorded in above table – 1.

Table No 1 :

	3 months assessment	12 months assessment	Total
Good	57	15	72
Fair	17	12	34
Poor	0	2	2
	74	34	108

Gupta SK et al (1989) used modification of grading by Sharma and Sharkaran. They used five criteria's, which include back pain, relief of leg pain, and spinal movement, occupation and patients satisfaction as shown in table 2 and 3.

Table No 2 :

	3	2	1	0
Relief of back pain	Total	Marked	Partial	Nil
Relief of leg pain	Total	Marked	Partial	Nil
Spinal movements	Full	Partial restriction	Partial restriction with pain	Confined to bed
Occupation	Same as before	With less eficiency	Changes to light occupation	No occupation
Patient Satisfaction	Fully satisfied	Satisfied	Partial	Unhappy

Table No 3 :

Grading	No. of cases	Percentage
Excellent (13-15 points)	30	55.6
Good (10-12 points)	16	29.6
Fair (6-9 points)	8	14.8
Poor (< 6 points)	0	Nil

Mac Nab's criteria is also used for evaluation of results of disc surgery. We have used this methodology in evaluation. [24,26]

In the study Juage et al out of 381 patients 89% and 86% were followed up for a period of 6 months and 12 months respectively. Outcome criteria was modified from Stauffer - Coventry Scale. LBP of 6 or 7 on VAS, reduced working ability for > 6 m.

No return to previous job, regular visits to treating physicians or hospital stay has been chosen as a criterion for bad outcome.

- Good: None of the above mentioned criteria.
- Moderate: 1 of above or 2 of above with back pain of 0 – 3 on VAS.
- Bad: 2 criteria and back pain > 3 on VAS or all three criteria.

51.5% had good outcome, 28.4% moderate and 20.1% had bad outcome at 12 month follow up.

So, we have seen that for analyzing outcome of lumbar disc disease various authors have chosen criteria which differ from study to study and duration of follow up also differs significantly.

For analyzing functional status there are long descriptive functional status questionnaire for low back pain which have a scoring pattern and are too complex to be used bedside clinically. E.g. Million visual analog scale, Roland's disability questionnaire, Wadell's disability index, Back pain function scale, Oswestry disability questionnaire. Although these scales define functional status more accurately, they are too complex to be used in clinical practice. We have used back pain function scale, which is as follows.[26]

There is a definite need of criteria, which should consist both of patient's estimates of his or her condition in quantitative fashion and physician's judgment of patient's conditions. A simple semiquantitative, universally acceptable and applicable scale analyzing the data from a treatment regimen is imperative.

Japanese Orthopaedic Association (JOA) satisfies some of the above criteria's. The Japanese Orthopaedic Association (JOA) score is widely used to assess the severity of clinical symptoms in patients with lumbar compressive myelopathy, particularly in East Asian countries. We recorded the criteria for low back pain, both

before and after surgery, according to the Japan Orthopedic Association (JOA) score and the rate of improvement (RI). The RI (%) was calculated by dividing the post-operative score minus the pre-operative score by 15 minus the pre-operative score, and multiplying by 100.[72]

JAPANESE ORTHOPAEDIC ASSOCIATION'S

LOW BACK ACHE SCORE

1. Subjective symptoms	Score
A. Low Back pain (3points)	
a. No Low Back pain	3
b. Occasional mild low back	2
c. Low back pain always present / Severe low back pain occurs occasionally	1
d. Severe low back pain always present	0
B. Leg pain and / or tingling (3 points)	
a. No lower extremity pain or numbness	3
b. Occasional mild lower extremity pain and numbness	2
c. Lower extremities pain and numbness always present / Severe lower extremities pain and numbness occur occasionally	1
d. Severe lower extremities pain and numbness always present	0
C. Ability to walk (3 points)	
a. Normal walking	3
b. Walking at least 500m is possible, but pain, numbness & weakness are felt	2
c. In walking 500m or less, pain, numbness and weakness occur, and Walking becomes impossible.	1
d. In walking at most 100m, pain, numbness and weakness occur, and Walking becomes impossible.	0

2.	Objective findings.	Score
	A. SLRT	
	a. Normal	2
	b. 30degree – 70 degree	1
	c. Less than 30 degree	0
	B. Sensory Abnormality	
	a. Normal	2
	b. Mild sensory disturbance (Hypoesthesia)	1
	c. Distinct sensory symptoms (Anesthesia)	0
	C. Motor Abnormality	
	a. Normal	2
	b. Slightly decreased muscle strength	1
	c. Markedly decreased muscle strength	0
	Total score	15
	Rate of Improvement = post op score – pre op score / 15-pre op score x	100

Contraindications for lumbar disc surgery by B. E. Finnesan[63]

- A first episode of low back pain or sciatica without an adequate trial of conservative treatment.
- Intermittent low back pain associated with occasional pains of an equivocal nature extending into one or other lower extremity and equivocal results on radiological imaging.
- Low back pain and intermittent sciatica with non-conforming radiological finding.
- Improvement of patient.

Poor results were predicted in patients with:

- Back pain primarily.
- Gross obesity.
- Non-organic signs and symptoms.
- Poor psychological background.
- Secondary gain.
- History of previous lawsuit.

MATERIALS AND METHODS

STUDY AREA AND STUDY POPULATION:

- This is a prospective study, conducted in the department of Orthopaedics in BLDEU'S Shri B.M.Patil's Medical College, Hospital and Research Centre, Vijayapur with diagnosis of single level or two level lumbar disc prolapse from October 2013 - August 2015 were considered for the study if they fulfilled following criteria.

INCLUSION CRITERIA:

1. Patient aged 18 years and above.
2. Single level or two level lumbar disc prolapse.
3. Failure to respond to non-operative treatment.

EXCLUSION CRITERIA:

1. Patients below the age of 18 years.
2. Multiple level disc herniation
3. Vertebral fractures.
4. Disc prolapse with bowel and bladder symptoms (cauda equina syndrome).
5. Patient with scoliosis or kyphosis.

SAMPLING:

- Time period of study – October 2013- August 2015
- With the incidence rate of lumbar disc prolapse cases undergoing surgery 0.07% [70/100000] at 95% confidence interval and $\pm$ 1 margin of error the sample size is n= 26.

$$n = \frac{(Z_{\alpha})^2 \times p \times q}{d^2}$$

Hence a minimum no. of 26 patients were included in this study.

4. **STATISTICAL ANALYSIS**:

- Diagrammatic presentation
- Mean ± S.D.
- Chi- Square Test or Mc Nemers Chi- Square Test.
- Paired 'T' test or suitable non parametric test in case of skewed data (if necessary).

The study was approved by local ethics committee. A detailed history was obtained at the time of admission and all the patients were subjected to thorough clinical examination. All patients were subjected MRI.

The findings obtained therein were noted in a proforma (as per Annexure III).

All the cases were assessed preoperatively and postoperatively with the Japanese Orthopaedic Association low back ache score. The results of surgery are evaluated using Mac Nab's criteria.

After detailed clinical evaluation, the patients had undergone relevant investigations like:

- X-ray Lumbo-Sacral spine both AP/Lat Views.
- X-Ray Lumbo-Sacral Spine Lateral view in Flexion and Extension.
- Blood routine – Hb%, BT, CT, FBS, PPBS, Blood urea, Sr. Creatinine.
- Chest X-ray.
- ECG for fitness for anaesthesia.
- Consent of the patient for the surgery.

All the patients were operated in prone position. Some patients in knee chest position and some patients on bolsters.

A surgical procedure carried out was conventional standard discectomy by fenestration technique. Only extruded disc was removed. No disc space curettage was done. Nerve root was cleared of compression in all cases.

JOA rating scale was used to determine the outcome apart from Mac Nabs's criteria. The total score represents the sum of subjective symptoms and objective findings . The RI (%) was calculated by dividing the post-operative score minus the pre-operative score by 15 minus the pre-operative score, and multiplying by 100.

POSTOPERATIVE MANAGEMENT

- Pain was controlled with injectable and oral NSAIDS.
- Postoperative antibiotic were administered for 3 days.
- Neurological function was monitored.
- Turning in bed was allowed on the operative day.
- Patients were allowed to sit up on 2^{nd} post-operative day.
- Lower limb strengthening exercises were started on 2^{nd} post-operative day.
- Back strengthening exercises were started on 14th post-operative day.
- Patient were mobilized with brace on 2^{nd} post-operative day.
- Sutures were removed on 12^{th} post-operative day.
- Stooping and flexing the spine excessively were avoided by patients on advice.
- At discharge patient were advised not to strain the back or lift weights.
- Patients were instructed to minimize sitting and riding in a vehicle 6 months post-operatively.

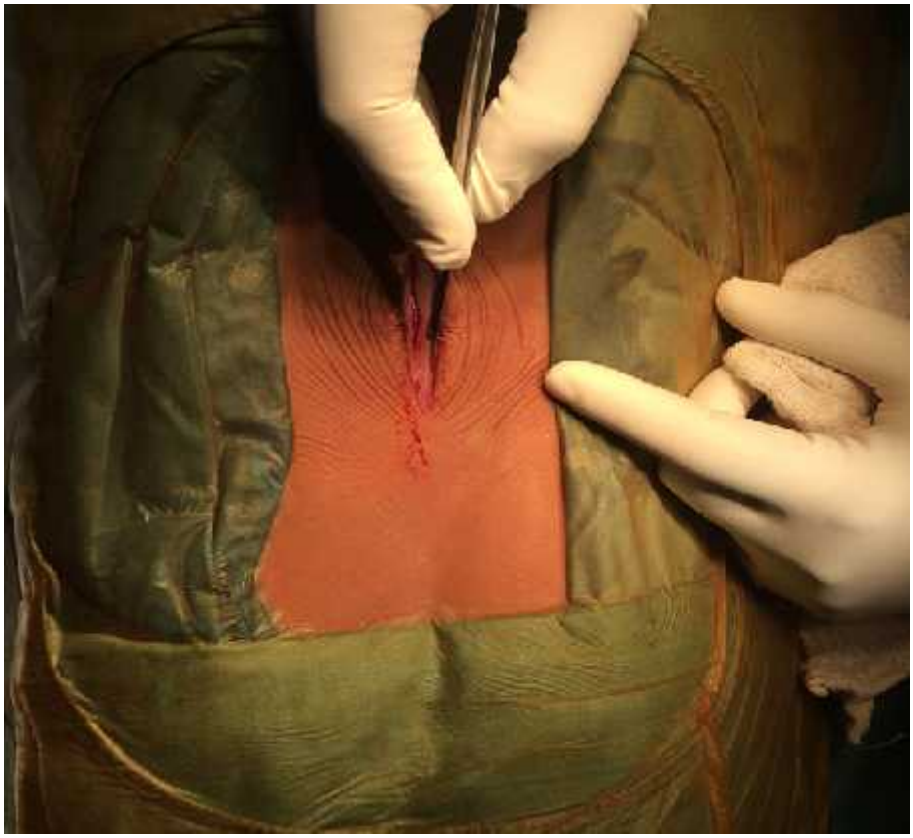
Fig. No 16 OPERATIVE PHOTOGRAPHS

Patient positioned prone over bolsters. Abdomen allowed to hang free so that intra venous pressure is decreased and due to collapse of epidural venous plexus blood loss is decreased and part is thoroughly painted and draped.

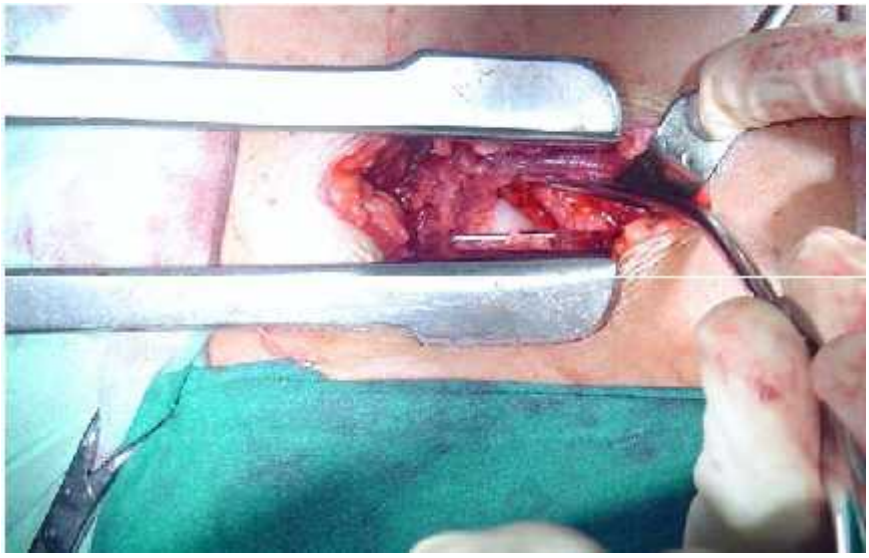
Patient in knee chest position

Infiltration of skin and subcutaneous tissue with a 1: 500,000 epinephrine solution to aid hemostasis.

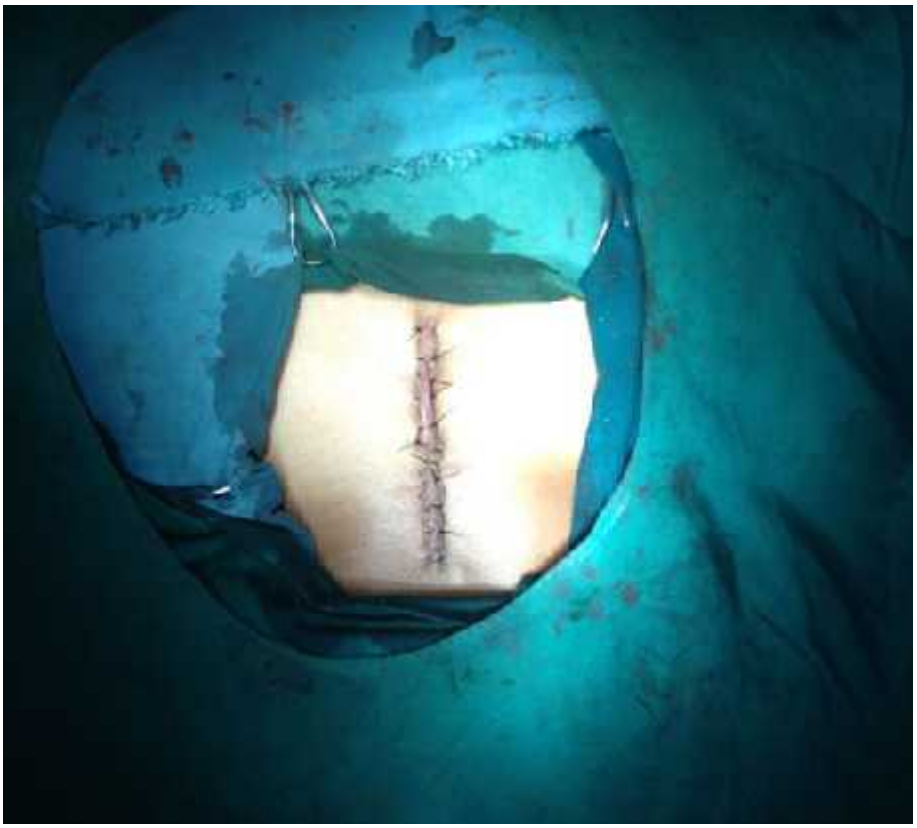
Midline skin incision centered over the involved lumbar segment.



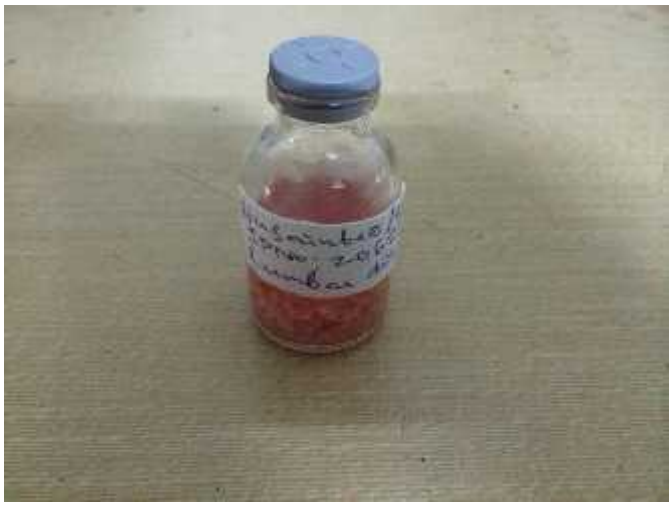
Exposure of the prolapsed disc



Skin closure using nonabsorbable sutures.

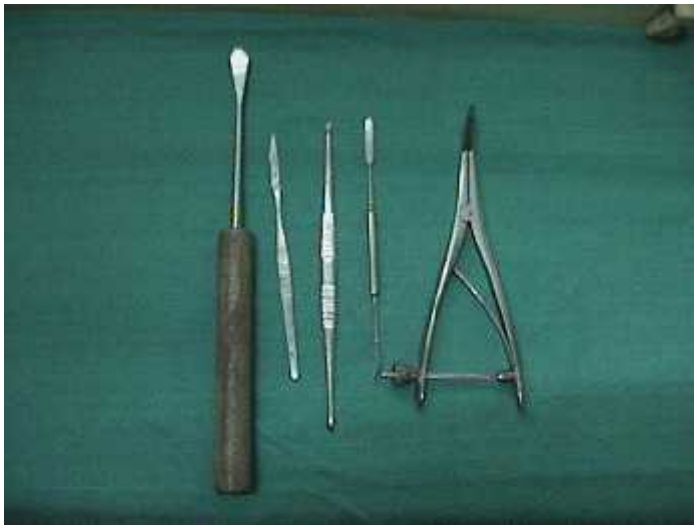


Extruded disc removed at surgery



Angulated Kerrison rongeurs and pituitary forceps.

Cobb's periosteal elevator, Bayonet-pointed knife, Curet, McDonald's retractor and lamina spreader.



CASE 1

Pre surgery SLRT LEFT Side 30^0

Post surgery SLRT LEFT Side 80^0

OBSERVATIONS AND RESULTS

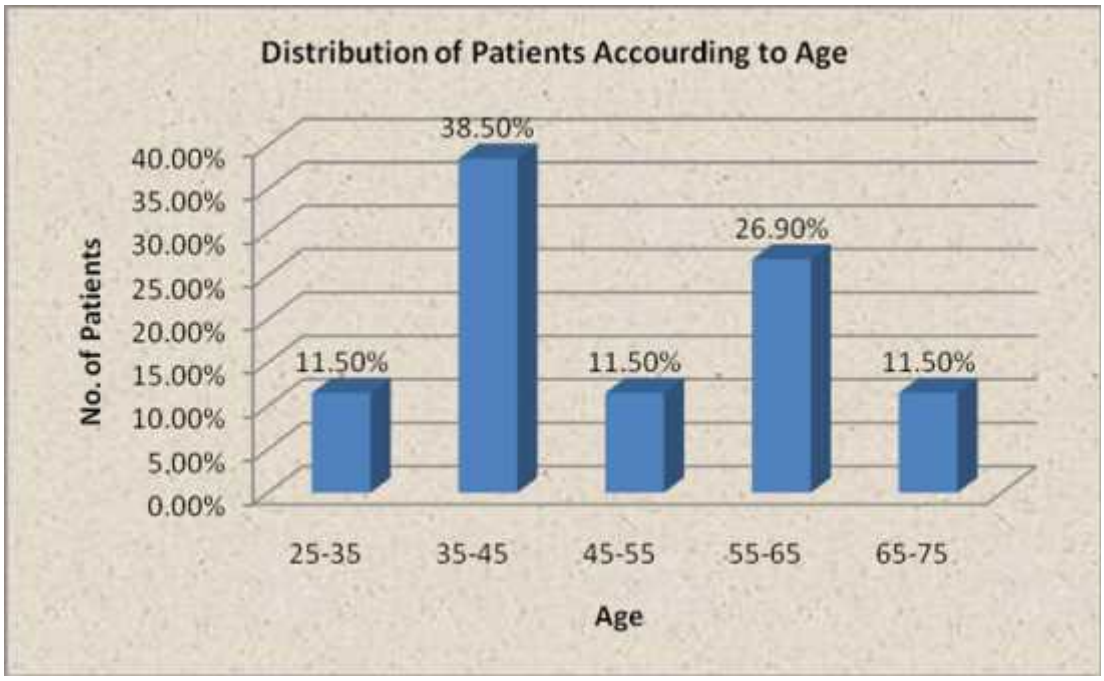
OBSERVATIONS:

Total 26 patients were included in the study. All 26 patients were available for follow up by visits. All the patients were followed up at the interval of 1 month, 3 months and 6 months. At the end of 1 month and 6 months assessment was done of subjective and objective findings with Japanese Orthopaedic Association (JOA) score and Rate of improvement (RI) was calculated. Out of 26 patients 18 were men and 8 were women. Age ranges from 28 years to 72 years. Mean age being 47.8 years. In males age ranged from 28-72 years with mean 46.6 years. In females' age ranged between 35-70 years with a mean age of 50.5 years.

Table No. 4: Age in years

AGE	PATIENTS	%
25-35	3	11.5%
35-45	10	38.5%
45-55	3	11.5%
55-65	7	26.9%
65-75	3	11.5%

Graph No. 1: Age in year

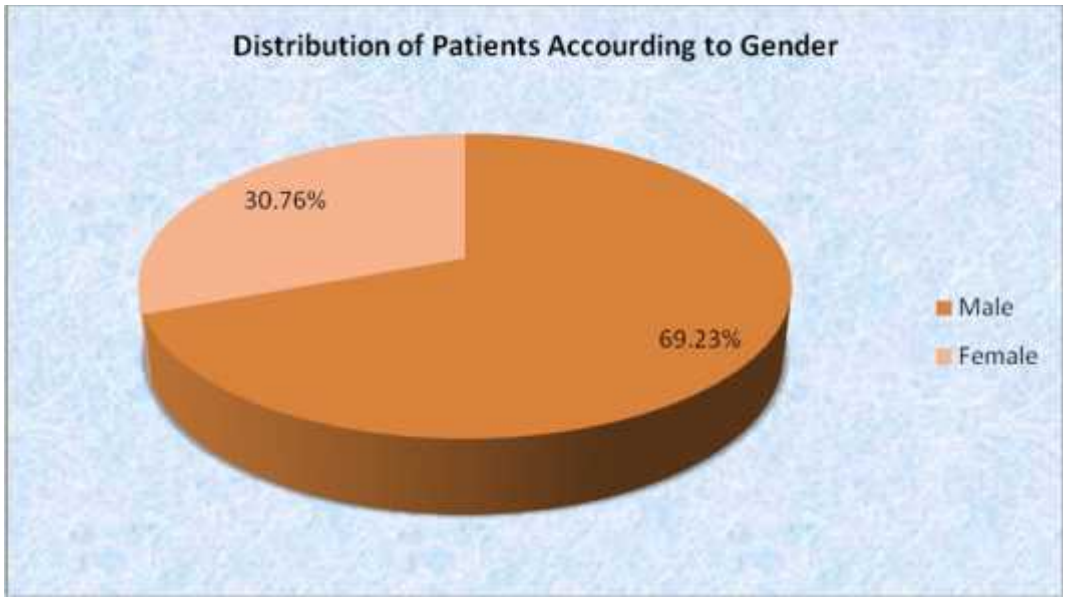


38.5% of the patients were between the age group of 35-45 years.

Table 5: Sex

Gender	Patients	%
Male	18	69.23%
Female	8	30.76%

Graph No 2 : Distribution of patients according to Gender



69.23 percent of the patients were males.

Table 6: Occupation

OCCUPATION	PATIENTS	%
BUSINESS	3	11.50%
AGRICULTURE	7	26.90%
SERVICE	6	23.08%
LABOUR	5	19.23%
HOUSEWIFE	5	19.23%

Graph No : 3

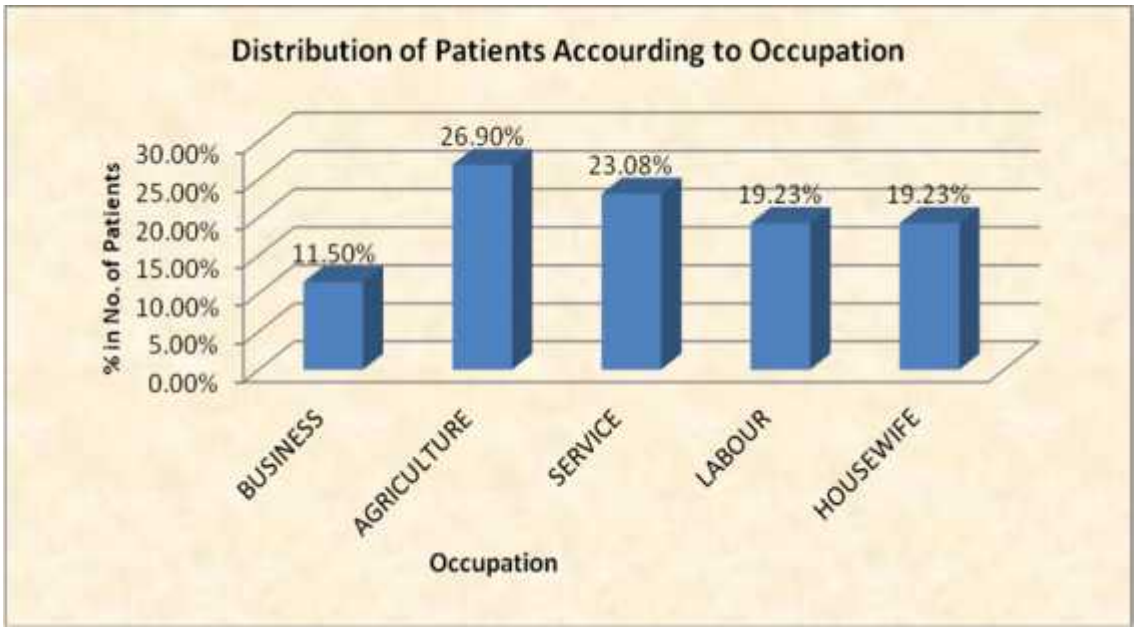


Table No. 7: Duration of symptoms in Months

DURATION OF SYMPTOMS	PATIENTS	%
8 TO 10	2	7.69%
10 TO 12	3	11.54%
12 TO 14	3	11.54%
14-16	5	19.23%
16 TO 18	0	0%
18 TO 20	7	26.92%
20 TO 22	2	7.69%
22 TO 24	4	15.38%

Graph No : 4

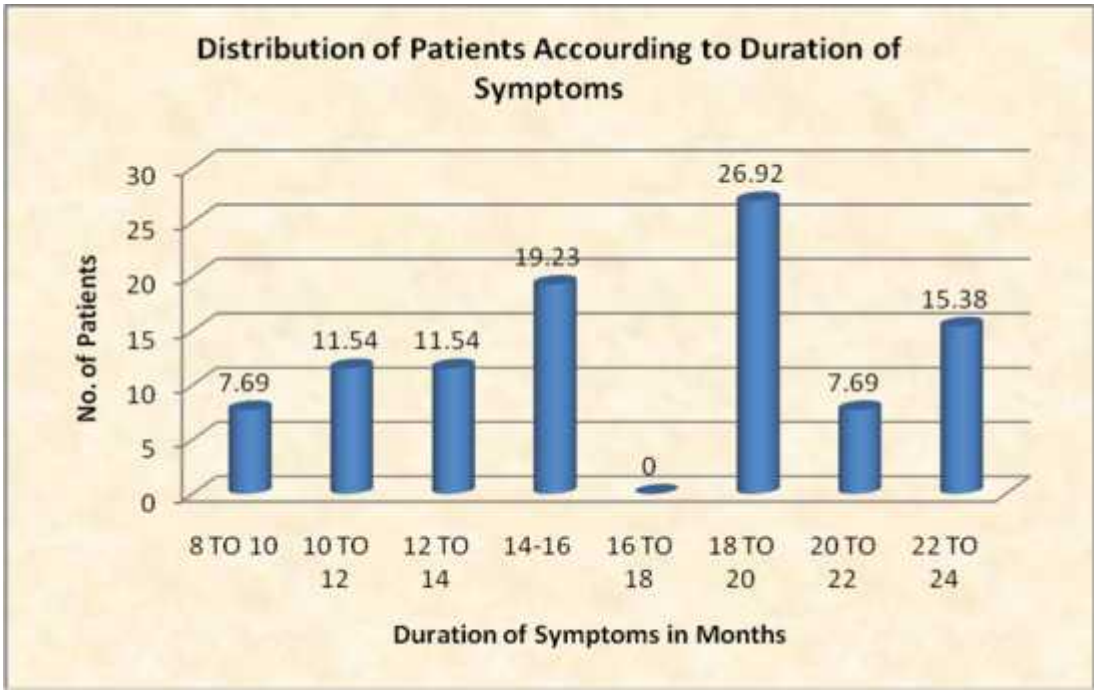
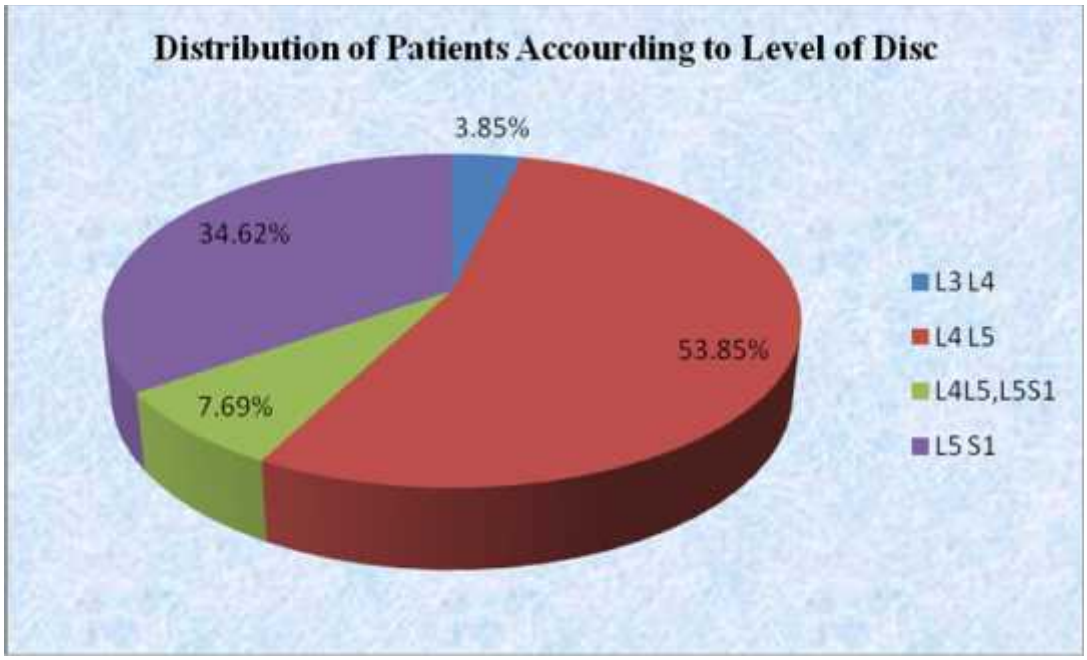


Table No. 8 : Involvement of disc spaces

LEVEL OF DISK	No.	%
L3 L4	1	3.85%
L4 L5	14	53.85%
L4L5,L5S1	2	7.69%
L5 S1	9	34.62%

Graph No. 5 :

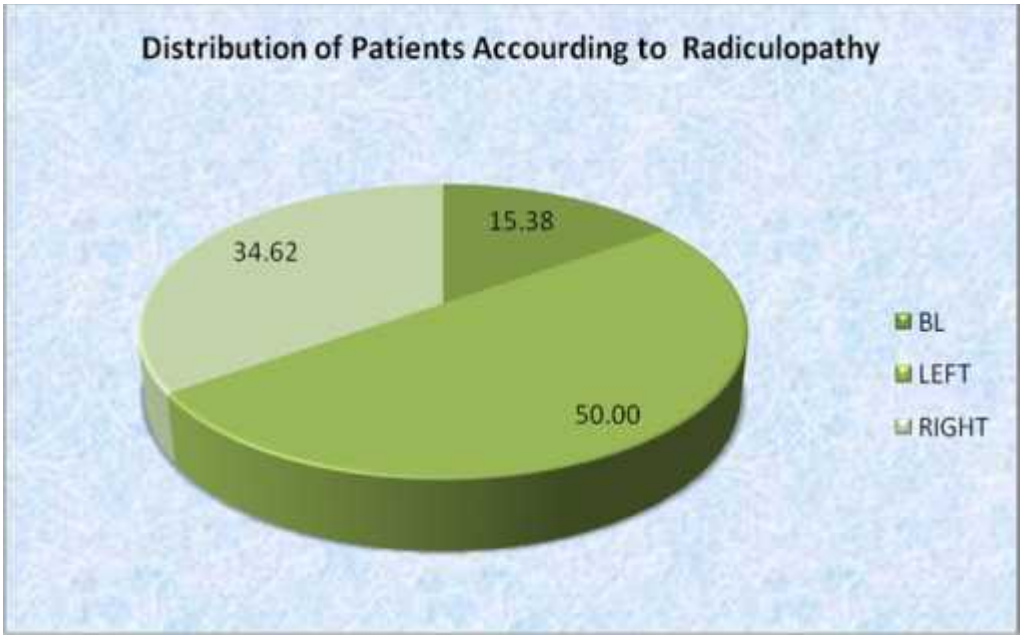


53.84 % of patients had L4 L5 disc space involvement.

Table No. 9 : Radiculopathy

RADICULOPATHY	PATIENTS	%
BL	4	15.38%
LEFT	13	50.00%
RIGHT	9	34.62%

Graph No. 6

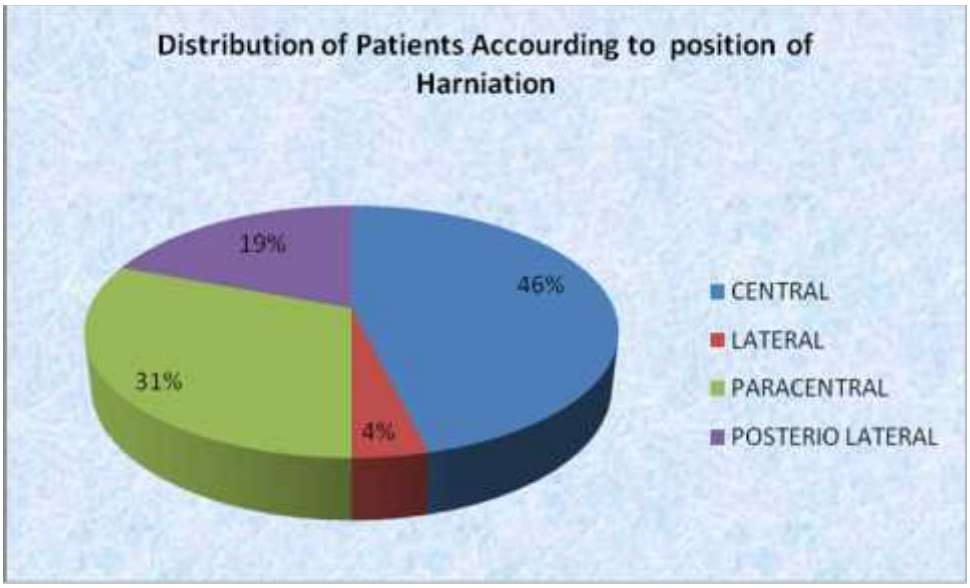


50 % of patients had Left sided radiculopathy.

Table No. 10 : Position of herniation

POSITION OF HARN	PATIENTS	%
CENTRAL	12	46.15
LATERAL	1	3.85
PARACENTRAL	8	30.77
POSTERIO LATERAL	5	19.23

Graph No. 7



In 46.15 % of patients the position of disc was central.

Only fenestration through ligamentum flavum was required in patients with disc prolapse at L5-S1 spaces (9 patients). A small amount of inferior lamina was removed inpatients with L4-5 level prolapse to approach the disc.

In patients with disc herniation at two levels L4-5 and L5-S1, simultaneous fenestration and discectomy was done at two levels. In all cases only prolapsed or extruded disc was removed and no disc space curettage was done.

Table No. 11 : Pre-op Epidural Steroid

EPIDURAL STEROID	PATIENTS	%
YES	18	69.23%
NO	8	30.76%

Graph No. 8

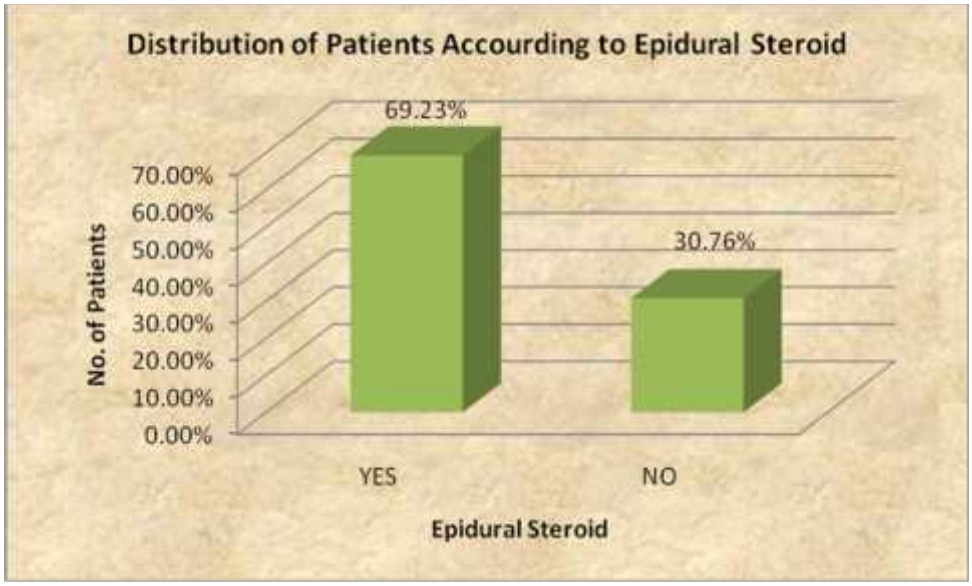
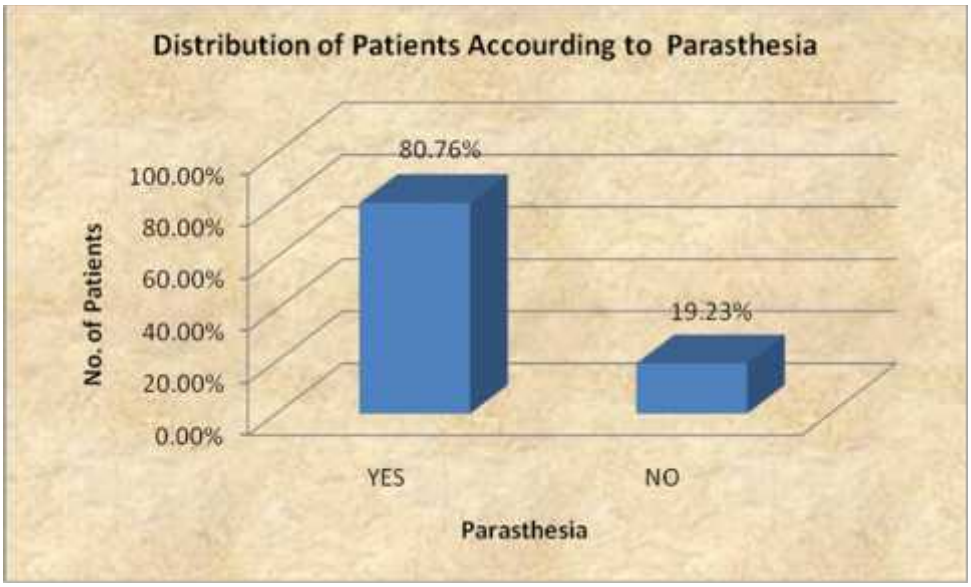


Table No. 12 : Pre-op parasthesia

PARASTHESIA	PATIENTS	%
YES	21	80.76%
NO	5	19.23%

Graph No. 9



All of the patients had both back pain and leg pain . In almost all the cases back pain preceded leg pain (sciatica) except in one case who had complained leg pain to start with. 9 patients had (Rt) sided radiculopathy and 13 patients had (Lt) sided radiculopathy. 4 patients had bilateral leg pain.

Table No. 13 : Neurological symptoms

Symptoms	**No of cases (n=26)**	**Percentage**
Back pain	26	100
Radicular pain	26	100
Parasthesia	21	80.76
Muscular weakness	17	65.38
Sensory symptoms (hypoesthesia / ansthesia)	7	26.92
Visceral involvement (bowel / bladder)	0	0

All 26 patients had undergone conservative therapy in the form of Bed rest, traction, analgesics or physiotherapy.

Table 14 : Conservative therapy

Therapy	Frequency
Bed rest	26
Analgesics and Muscle relaxants	26
Physiotherapy	26
Traction	26
Epidural steroid	18

All the modes of conservative treatment failed in these patients. The patients who received epidural steroids had a brief period of relief of symptoms of about 3-4 months but to recur afterwards with increased intensity.

Traction was used in all patients. Patient was asked to lie supine and hips were flexed to 30^0 and knee to 30^0 and 4-5 kg traction was applied.

Bed rest was advised only for one week ranging form 4 days to 10 days. None of our cases had undergone any surgical treatment for lumbar disc prolapse.

Average duration of surgery: 75 min with a range of 45-100 min.

Average loss of blood: 200 ml with a range of 70 ml – 350 ml.

Blood transfusion was required in 7 patients, of these 2 patients had double level intervertebral disc prolapse who required two level fenestration simultaneously.

Motor and sensory deficit was divided into 3 categories mild, moderate and severe.

Sensory deficit was defined as;

- Mild up to 25% sensory loss in a particular dermatome.
- Moderate – upto 75% sensory loss in a particular dermatome.
- Severe – more than 75% loss.

A motor deficit was defined as;

- Mild - muscle power Grade 4/5 or > (MRC grading) in the myotome.
- Moderate -- Grade 3/5 in the myotome.
- Severe - Grade 2/5 and < or foot drop or involvement of more than one group of muscles.

Table No. 15: Neurological Deficits

Defecit	Mild	Moderate	Severe
Sensory deficit	5	1	1
Motor deficit	11	4	2

Table No. 16: Immediate complications of surgery

Complications	Frequency
Dural tear	1
CSF leak	0
Significant epidural bleding	5
Wound infection	1
Discitis	0
Neural damage	0

One patient with dural tear required suturing of dura with absorbable suture (No. 4.0 vicryl) and a fat graft. Epidural bleeding was controlled by bipolar cautery and packing. 1 case of superficial wound infection required wound dressing and 3 days of antibiotics.

All patients were catherised for 24 hrs post surgery.

Fortunately none of the above complications affected the final outcome.

Postoperative regime

3rd generation cephalosporin for 3 days with aminoglycoside (Gentamycin or amikacin). Analgesics as requested by patient (NSAID). No opioids were used in the postoperative stay.

Patient was asked to ambulate on the immediate next post-operative day. All sutures were removed at 12 days.

Back strengthening exercises (Back-school training) were taught form 2nd week onwards).

Surgical outcome

For analyzing the clinical outcome of fenestration – discectomy, we have used following criteria

1. Japanese Orthopaedic Association score for pre-operative and post-operative objective and subjective symptoms and Rate of improvement at 1 month and 6 months.
2. Mac Nab's criteria of outcome.

- **Excellent** No pain; no restriction of mobility return to normal work & level of activity
- **Good** Occasional nonradicular pain relief of presenting symptoms; return to modified work
- **Fair** Some improved functional capacitystill handicapped and unemployed
- **Poor** Continued objective symptoms of root involvement; additional operative intervention needed at the index level irrespective of length of postoperative follow-up

Out of 26 patients at the time of discharge, 20 patients (87.5%) could walk independently without any aid and without any radicular pain. 6 patients with little

radicular pain and with support.

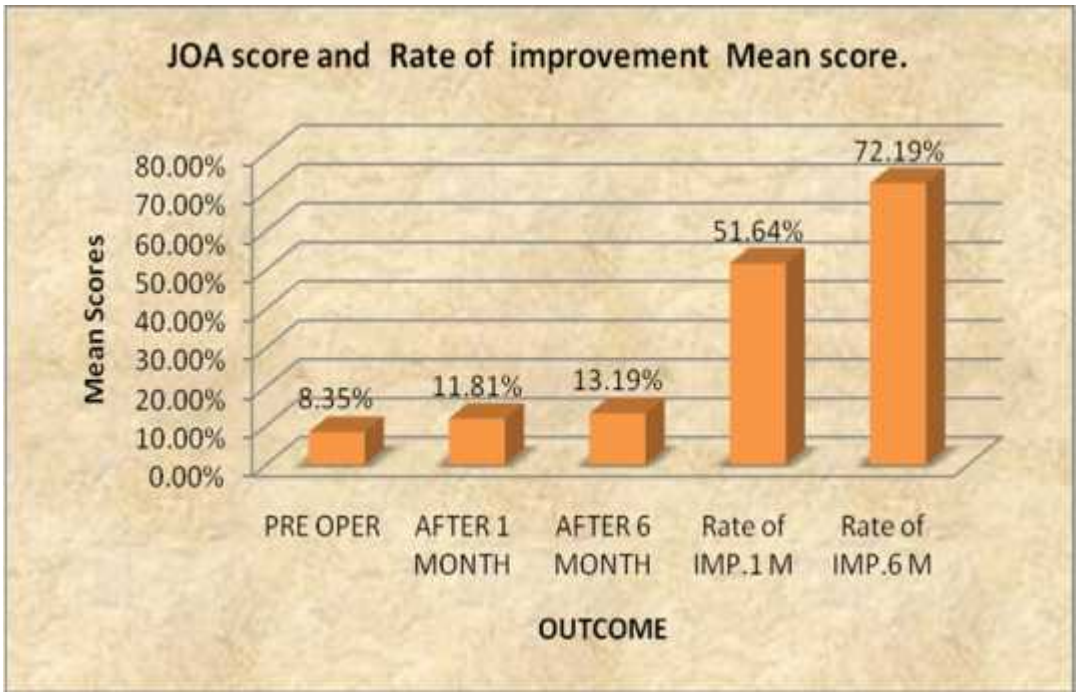
In most of the patients 19 (73.07%) sciatica improved immediately.

The clinical outcome of 26 patients after a mean follow up of 6 months is as follows:

Table No. 17: JOA score and Rate of improvement Mean score.

JOA	MEAN
PRE OPER	8.346
AFTER 1 MONTH	11.807
AFTER 6 MONTH	13.19
Rate of IMP.1 M	51.635
Rate of IMP.6 M	72.191

Graph No. 10



The pre-operative mean±SD (SE) JOA score was 8.346±0.85(0.169) which improved to 11.807±0.694(0.136) after 1 month and 13.19±0.895(0.175) after 6 months.

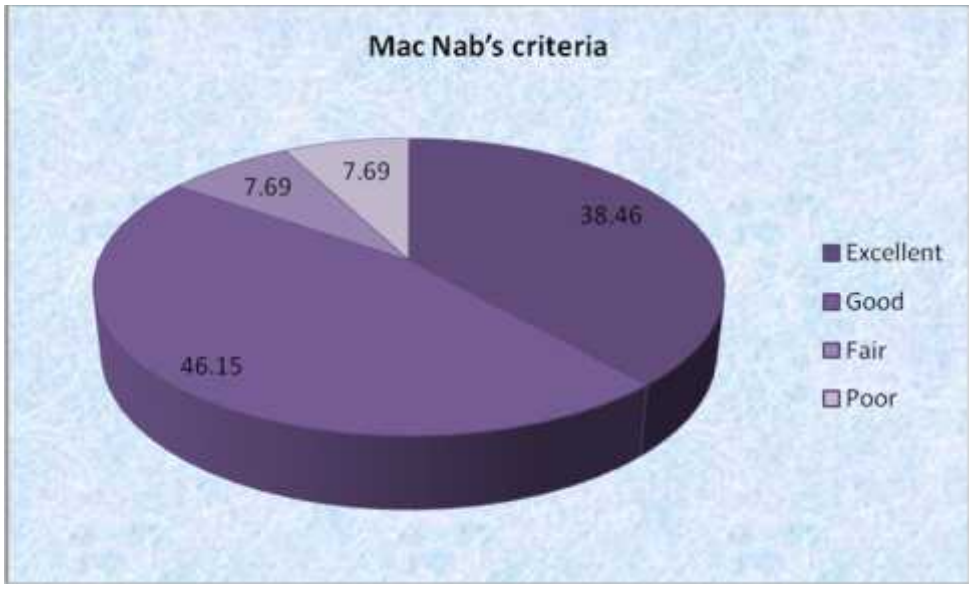
A Wilcoxon paired signed rank test . Showed that the above changes were statically significant (P<0.0001 HS) which shows a significant reduction in patient's perception of pain.

The 1 month mean±SD (SE) Rate of improvement (RI) was 51.635±10.09 (1.797) and after 6 months was 72.191±12.8(2.511) . A Wilcoxon paired signed rank test. Showed that the above changes were statically significant (P<0.0001 HS).

Table No. 18 : Mac Nab's criteria

Mac Nab's criteria	Frequency	Percentage
Excellent	10	38.46
Good	12	46.15
Fair	2	7.69
Poor	2	7.69

Graph No. 11



DISCUSSION

Lumbar disc disease is one of the common conditions encountered by orthopedic surgeons. Upto 70% of the population will experience back pain sometime in their life.

Back pain due to lumbar intervertebral disc prolapse contributes to the chunk of problems related to back pain. The lumbar disc disease though not contribute to mortality, it contributes to morbidity and economic loss due to the number of work hours lost.[24]

Recovery from sciatica makes early surgery likely to be more cost effective than prolong conservative care[73]. A Cochraine review summarized some trials evaluating surgery and chemonucheolysis for prolapsed disc, showing better results with surgery than chemonucheolysis[74]. The standard treatment of prolapsed lumber disc has been surgical excision of the disc, though the methods of discectomy vary. The traditional view has been that wide laminectomy produces increased morbidity compared to less extensive procedures like inter-laminar fenestration[75]. Hence fenestration has been done for all patients in the present study.

Love devised inter-laminar fenestration[9]. Refinement of fenestration technique was described by William who used an operating microscope to facilitate better visualization of dural sac, nerve roots and other inter-spinal structures including the prolapsed disc[10].

Results of this study, state that the lumbar discectomy performed with a limited disc excision by fenestration is a safe, effective and reliable method for treating selected patients with herniated lumbar discs. No patients in this study deteriorated after surgery.

The length of a patient's recovery period after surgery appeared to be strongly influenced by environmental factors and patient's motivation. In majority of patients with excellent and good results, the preoperative sciatic symptoms improved within first three days after surgery. The approach herein differs from microdiscectomy only in extent of exposure.

The disc removal per se in both is limited. Incision into the annulus fibrosus was necessary only when a protruded disc herniation was identified. Additional exposure in fenestration has the advantage of correcting lateral recess stenosis. Surgeon must be prepared to perform foraminotomy or undercutting of upper or lower lamina in addition to lumbar disectomy if the nerve root remains tight after disc excision.

We observed 26 patients with follow up at 1 month, 3 months, 6 months.

Age distribution:

- Majority of the patients in our study were in the age group between 35-45 yrs (38.5%) and age ranges were from 28 years to 72 years. Mean age being 47.8 years.
- In SS Sangwan et al the average age was 38.22 years ranging from 25-50 years.[4]
- In Riaz et al the average age was 34.31 years ranging from 19-52 years.[31]

Sex distribution of patients:

- In our present study 18(69.23%) patients were male and 08(30.77%) were female.
- In SS Sangwan et al the 18 patients were male and 08 were female.
- In Riaz et al the Out of 109 patients 60 were males and 49 were females.

Occupation of the patients:

- 46.15% of the patients were involved in significant occupations namely as daily wage workers or agriculturists.
- Kelsey and White[76] in 1980 reported that the risk of being hospitalized for a herniated disc or sciatica was lowest in professionals and highest in manual workers and motor vehicle drivers.
- Hult L.[77] in 1954 showed a linear increase in disc degeneration, to nearly 100 percent in workers performing heavy physical work.

Pre-operative pain

- Among 26 patients all patients back pain with radiculopathy with 13(50%) patients with Lt sided radiculopathy.
- In SS Sangwan et al 15(57.63) patients had Left sided radiculopathy.

Duration of symptoms

The duration of symptoms was between 18-20 months in 7 patients (26.92%); between 14-16 months in 5 patients (19.23%).

Side

- Symptoms were left sided in 13 patients (50%) and right sided in 9 patients (34.61%) and 4 patients (15.38) had bilateral in our study.
- In Riaz et al 65 patients had left sided symptoms while 44 had right sided.

Pre-operative Sensory symptoms:

7 patients had sensory deficit with 5 having mild, 1 moderate and 1 severe.

Pre-operative Motor weakness:

17 patients had motor weakness 11 having mild, 4 moderate, and 2 severe.

Epidural steroid:

18 patients had epidural steroid prior to surgery and had relief for 3-4 months.

Investigations:

- Magnetic resonance imaging studies was done in all the patients.
- L4L5 was affected in 14 patients (53.84%); L5S1 in 9 patients (34.61%); L3L4 in 1 patients (3.84%) and L4L5-L5S1 in 2 patients (7.69) in our study.
- In Riaz et al the most common level of involvement was L4 -L5 (n=67) followed by L5 -S1 (n=42).

JOA score:

- The pre-operative mean±SD(SE) JOA score was 8.346±0.85(0.169) which improved to 11.807±0.694(0.136) after 1 month and 13.19±0.895(0.175) after 6 months.
- A Wilcoxon paired signed rank test. Showed that the above changes were statically significant (P<0.0001 HS).
- The 1 month mean±SD(SE) Rate of improvement (RI) was 51.635±10.09(1.797) and after 6 months was 72.191±12.8(2.511) . A Wilcoxon paired signed rank test. Showed that the above changes were statically significant (P<0.0001 HS).

Mac Nab's criteria:

- According to Mac Nab's criteria we had excellent outcome in 10(38.46%) patients and good in 12(46.15%) patients.
- In SS Sangwan et al based on modified Macnab criteria 17 patients had excellent, 6 good and 2 fair results.
- In Babu MKV et al according to Mac Nab's criteria they had good outcome in 29 (90.6%) of patients.[5]

CONCLUSION

1. Interlaminar discectomy by Fenestration technique is a safe and reliable method for treating patients with lumbar disc prolapse who have been closely scrutinized for surgery.
2. We have a excellent outcome in 10 (38.46%) patients and 12 (46.15%) patients had good outcome and this result can be credited to careful selection of candidates for surgery.
3. Fenestration technique is a safe procedure compared to extensive laminectomy and discectomy, which destabilizes the spine very much.
4. Change in the outcome score gives better idea of the recovery compared to preoperative state in addition to total postoperative JOA scale.
5. Rate of improvement is a good indicator of post-operative improvement in subjective symptoms and objective findings

SUMMARY

Low backache is a common ailment in the general population and 80% of the adults experience it in some point of time in their life. Lumbar disc herniation is a common cause for the same. Of the numerous methods of discectomy for the treatment of lumbar disc herniation, discectomy by fenestration method is one of the procedures. This study analyzed the functional and neurological recovery following the surgery.

26 patients were followed up for a period of 6 months following this surgery and outcome was analyzed. The Japanese orthopaedic association score showed good functional recovery and also showed that good relief from the radicular pain was achieved following fenestration and discectomy. The change in JOA score between the preoperative and postoperative status was also analyzed.

Good neurological and functional recovery was noted in the patients. Thus, it is clear from the study that fenestration discectomy is an effective surgery for functional and neurological recovery of patients with lumbar disc prolapse.

FIG. NO. 17 CLINICAL PHOTOS

Case 2

Pre-op R-side SLRT 30^0

Post-op R-side SLRT 60^0

Case 3

Pre-op L-side SLRT 40^0

Post-op L-side SLRT 70^0

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ANNEXURE – I

B.L.D.E.UNIVERSITY'S
SHRI.B.M.PATIL MEDICAL COLLEGE, BIJAPUR-586 103
INSTITUTIONAL ETHICAL COMMITTEE

Institutional Ethical Committee BIJAPUR-586 103. OUTWARD No. 58/13 Date 14-11-13 Shri B.M. Patil Medical College

INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

The Ethical Committee of this college met on 13-11-2013 at 3-30pm to scrutinize the Synopsis of Postgraduate Students of this college from Ethical Clearance point of view. After scrutiny the following original/corrected & revised version synopsis of the Thesis has been accorded Ethical Clearance.

Title "A Prospective study of Surgical Management of lumbar disc prolapse by fenestration technique" —x—x—

Name of P.G. student Alaf Ayub Pathan
Department of Orthopaedics

Name of Guide/Co-investigator Dr. Ashok. R. Nayak Prof
Department of Orthopaedics.

DR.TEJASWINI VALLABHA
CHAIRMAN
INSTITUTIONAL ETHICAL COMMITTEE
BLDEU'S, SHRI.B.M.PATIL
MEDICAL COLLEGE, BIJAPUR.

Following documents were placed before E.C. for Scrutinization
1) Copy of Synopsis/Research project.
2) Copy of informed consent form
3) Any other relevant documents.

ANNEXURE – II

INFORMED CONSENT FORM

BLDEU'S SHRI B. M. PATIL MEDICAL COLLEGE HOSPITAL AND RESEARCH CENTRE, VIJAYAPUR- 586103.

TITLE OF THE PROJECT - A PROSPECTIVE STUDY OF SURGICAL MANAGEMENT OF LUMBAR DISC PROLAPSE BY FENESTRATION TECHNIQUE.

PRINCIPAL INVESTIGATOR - DR. ALAF AYUB PATHAN

P.G.GUIDE NAME - DR. ASHOK.R.NAYAK M.S. (ORTHO)

PROFESSOR OF ORTHOPAEDICS

All aspects of this consent form are explained to the patient in the language understood by him/her.

I) INFORMED PART

1) PURPOSE OF RESEARCH:

I have been informed that this study is a study of surgical management of lumbar disc prolapse by fenestration technique. I have also been given a free choice of participation in this study. This method requires hospitalization.

2) PROCEDURE:

I am aware that in addition to routine care received, I will be asked series of questions by the investigator. I have been asked to undergo the necessary investigations and treatment, which will help the investigator in this study.

3) RISK AND DISCOMFORTS:

I understand that I may experience some pain and discomfort during the examination or during my treatment. This is mainly the result of my condition and the procedure of this study is not expected to exaggerate these feelings that are associated with the usual course of treatment.

4) BENEFITS:

I understand that my participation in this study will help to study the surgical management of lumbar disc prolapse by fenestration technique.

5) CONFIDENTIALITY:

I understand that the medical information produced by this study will become a part of Hospital records and will be subject to the confidentiality and privacy regulation. Information of a sensitive personal nature will not be a part of the medical records, but will be stored in the investigator's research file and identified only by a code number. The code-key connecting name to numbers will be kept in a separate location.

If the data are used for publication in the medical literature or for teaching purpose, no name will be used and other identifiers such as photographs and audio or videotapes will be used only with my special written permission. I understand that I may see the photographs and videotapes and hear the audiotapes before giving this permission.

6) REQUEST FOR MORE INFORMATION:

I understand that I may ask more questions about the study at anytime. Dr. Alaf Ayub Pathan is available to answer my questions or concerns. I understand that I will be informed of any significant new findings discovered during the course of the study, which might influence my continued participation.

If during the study, or later, I wish to discuss my participation in or concerns regarding this study with a person not directly involved, I am aware that the social worker of the hospital is available to talk with me. A copy of this consent form will be given to me to keep for careful reading.

7) REFUSAL OR WITHDRAWAL OF PARTICIPATION:

I understand that my participation is voluntary and that I may refuse to participate or may withdraw consent and discontinue participation in the study at any time without prejudice to my present or future care at this hospital. I also understand that Dr. Alaf Ayub Pathan may terminate my participation in the study after he has explained the reasons for doing so and has helped arrange for my continued care by my own physician or physical therapist, if this is appropriate.

8) INJURY STATEMENT:

I understand that in the unlikely event of injury to me resulting directly from my participation in this study, if such injury were reported promptly, the appropriate treatment would be available to me, but no further compensation would be provided. I understand that by my agreement to participate in this study I am not waiving any of my legal rights.

I have explained to _____the purpose of the research, the procedures required and the possible risks and benefits to the best of my ability in patient's own language.

_____ _____

Dr. Alaf Ayub Pathan Date

(Investigator)

II) **STUDY SUBJECT CONSENT STATEMENT:**

I, the undersigned have been explained by Dr. ASHOK NAYAK in the language understood by me. The purpose of research, the details or procedure that will be implemented on me. The possible risks and discomforts of surgery and anesthesia have been understood by me. I have also been explained that participation in this medical research is solely the matter of my will and also that I have the right to withdraw from this participation at any time in due course of the medical research.

_____ _____

Participant / Guardian Date

_____ _____

Signature of Witness Date

ANNEXURE III

B.L.D.E.U'S SHRI B. M. PATIL MEDICAL COLLEGE HOSPITAL AND RESEARCH CENTRE, VIJAYAPUR- 586103.

PROFORMA

NAME

AGE

SEX

OCCUPATION

ADDRESS

DETAILS OF FIRST ADMISSION

DOA-

DOS-

DOD-

IP –

CHIEF COMPLAINTS (Duration, Details of each complaint)

-Pain

-Radiculopathy,

- Motor, Sensory involvement

-Bowel / Bladder involvement

TREATMENT RECEIVED PRIOR TO ADMISSION

-None

-Treatment taken (Duration, Details of each treatment)

Physiotherapy – Spinal exercises

S W Diathermy

Analgesics

Bed rest

Injections Epidural

Others

(Response to the conservative treatment if present = % of improvement duration of each treatment)

EXAMINATION ON ADMISSION

-Tenderness

-Swelling

-Local rise of temperature.

-Deformity of spine

-SLRT

-Motor Power

-Reflexes

-Sensory System

-Bowel / Bladder

-ROM of spine

INVESTIGATIONS:

- Blood – Hemoglobin, Total leukocyte count, Differential leukocyte count, Platelet count, ESR, S.Urea, S. Creatinine, Random Blood Sugar.
- Urine-Albumin, Sugar, Microscopy.
- Blood grouping and Rh typing.
- BT, CT.
- HIV, HbsAg.

-X-ray

-MRI –

-Level of disc prolapse

-Nerve root compression

- Type of herniation

PRE- OP JOA Low back ache score

1. Subjective Symptoms

    a) Low back pain –

    b) Leg pain and / Tingling –

    c) Ability to walk –

2. Objective findings

    a) SLRT –

b) Sensory Abnormality –

c) Motor Abnormality –

Total score –

SURGERY:

-Method, duration

-Per operative findings.

POST SURGERY:

-SLRT

-Motor & sensory systems

-Bowel & Bladder

-Subjective symptomatic relief

-Post surgery protocol

POST OP JOA LOW BACK ACHE SCORE –

-Rate of improvement - %

FOLLOW UP AFTER DISCHARGE –

1st). JOA low back ache score

-Rate of improvement - %

2nd). JOA low back ache score

-Rate of improvement - %

COMPLICATIONS:

MASTER CHART

Serial no.	Name	Age	Sex	IP NO.	Address	Occupation	DOS	Level of Disc H.	Dur. Of Sympt.	Radiculopathy	Position of Hern.	Pre-op JOA	1M JOA	6M JOA	Epi. Ste.	Rate of IM. 1 M	Rare of IMP.6 M	parasthesia	sensory sym	muscular weakness	Mac Nab criteria
1	MADIWALLAPPA BIRADAR	35	M	23879	SINDHGI	FARMER	13/9/13	L4-L5,L5-S1	14 months	BL	CENTRAL	9	12	13	yes	50	66.66	YES	NO	YES	GOOD
2	RAJASHREE HALLI	35	F	26180	BIJAPUR	HOUSEWIFE	25/9/13	L4-L5	18 months	left	CENTRAL	8	12	13	yes	57.14	71.42	YES	NO	YES	GOOD
3	PRABHAVATI GANI	55	F	765	BIJAPUR	HOUSEWIFE	18/11/13	L4-L5	24 months	left	PARACENTRAL	8	11	11	yes	42.58	42.58	YES	YES	YES	POOR
4	GURDAPPA MALLAPPA	33	M	313	TIKOTA	FARMER	21/11/13	L4-L5	12 months	left	CENTRAL	9	12	14	no	50	83.33	YES	NO	NO	EXCELLENT
5	NINGAMMA BIRADAR	55	F	2186	SINDHGI	LABOUR	29/1/14	L5-S1	15 months	right	CENTRAL	8	13	13	yes	71.42	71.42	YES	NO	NO	GOOD
6	SHIVALINGAPPA GALLAPPA	72	M	1884	MUDYABAL	FARMER	6/2/14	L5-S1	15 months	right	POSTERO-LATERAL	7	12	12	yes	62.5	62.5	YES	YES	YES	GOOD
7	YAMUNABAI CHODAVARAM	48	F	101020	BABLESHWAY	FARMER	4/4/14	L4-L5	20 months	left	CENTRAL	10	13	13	no	60	60	YES	NO	NO	FAIR
8	VIJAYLAXMI TALWAR	36	F	13208	BIJAPUR	HOUSEWIFE	3/5/14	L5-S1	18 months	left	PARACENTRAL	10	12	14	yes	40	80	NO	NO	NO	GOOD
9	AMBAWWA HUGAAR	70	F	14579	BIJAPUR	HOUSEWIFE	12/5/14	L4-L5	10 months	left	PARACENTRAL	8	13	13	yes	71.42	71.42	YES	NO	YES	GOOD
10	MALLAPPA GAIKWAD	40	M	17722	ZALKI	LABOUR	27/6/14	L4-L5	18 months	right	CENTRAL	9	12	12	yes	50	50	YES	NO	YES	FAIR
11	YALLAPPA BAHEVANT	33	M	17847	ATHNI	DRIVER	28/6/14	L4-L5	24 months	BL	CENTRAL	8	11	13	yes	42.85	71.42	YES	NO	NO	GOOD
12	MALLAPPA RAMAPPA	58	M	20620	BIJAPUR	TEACHER	17/7/14	L5-S1	9 months	right	PARACENTRAL	8	11	14	no	42.85	85.71	YES	NO	YES	EXCELLENT
13	HUSANBEE BAGALI	65	F	20623	TIKOTA	HOUSEWIFE	21/7/14	L4-L5	15 months	left	POSTERO-LATERAL	7	12	13	yes	62.5	75	YES	YES	YES	GOOD
14	BHIMANGOUDA DVAKAR	62	M	22219	BIJAPUR	FARMER	8/8/14	L3-L4	8 months	BL	CENTRAL	7	12	13	no	62.5	75	YES	YES	YES	GOOD
15	KAMALABAI BIRADAR	40	F	22922	KOLAR	LABOUR	14/8/14	L5-S1	18 months	left	PARACENTRAL	8	10	11	no	28.57	42.58	YES	NO	YES	POOR
16	MALLAPPA THAKUR	44	M	24335	BIJAPUR	ELECTRICIAN	21/8/14	L4-L5	10 months	right	CENTRAL	9	12	14	no	50	83.33	YES	NO	NO	EXCELLENT
17	IRRAPPA JALLAWAD	36	M	24826	SINDHGI	MECHANIC	23/8/14	L5-S1	10 months	left	PARACENTRAL	9	12	14	yes	50	83.33	YES	NO	YES	EXCELLENT
18	GIRISH BIRADAR	40	M	27138	TIKOTA	TEACHER	16/9/14	L4-L5,L5-S1	24 months	left	CENTRAL	9	12	14	yes	50	83.33	YES	NO	NO	EXCELLENT
19	GIRIMALLAPPA JAMAGOUDA	40	M	28173	BABLESHWAY	BUISSNESS	29/9/14	L4-L5	18 months	right	POSTERO-LATERAL	8	11	13	yes	42.85	71.42	NO	NO	NO	GOOD
20	PRAKASH BAGALI	48	M	29289	SINDHGI	BUISSNESS	1/10/14	L5-S1	18 months	left	POSTERO-LATERAL	9	12	13	no	50	66.66	YES	NO	YES	GOOD
21	RAJU NIKODI	28	M	35664	SINDHGI	LABOUR	11/12/14	L4-L5	18 months	BL	CENTRAL	8	11	14	no	42.85	85.71	YES	YES	YES	EXCELLENT
22	PRAVEEN KUNDAPPA	43	M	29289	BIJAPUR	MECHANIC	15/12/14	L5-S1	12 months	left	LATERAL	9	12	14	yes	50	83.33	YES	YES	YES	EXCELLENT
23	KANTAPPA MALLIKARJUN	60	M	37320	TIKOTA	FARMER	18/12/14	L5-S1	20 months	right	POSTERO-LATERAL	8	12	14	yes	57.14	85.71	NO	NO	NO	EXCELLENT
24	HANUMANT KARE	56	M	5142	SINDHGI	BUISSNESS	18/2/15	L4-L5	12 months	right	PARACENTRAL	8	11	14	yes	42.85	85.7	YES	YES	YES	EXCELLENT
25	CHANNAPPA BIRADAR	60	M	5724	BIJAPUR	LABOUR	24/2/15	L4-L5	24 months	right	PARACENTRAL	9	12	14	yes	50	83.33	NO	NO	YES	EXCELLENT
26	CHANNAPPA GUNDAPPA	51	M	6118	BIJAPUR	FARMER	27/2/15	L4-L5	15 months	left	CENTRAL	7	12	13	yes	62.5	75	NO	NO	YES	GOOD